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RESPONSE OF TOMATO (*Lycopersicum esculentum* var. Mill) TO DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS FERTILIZER IN SOUTH WESTERN NIGERIA

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Abstract

A randomized complete block experiment was carried out at the teaching and research farm of Federal University of Technology, Akure (7°16'N, 5°12'E) located in the rain forest vegetation zone of Nigeria, to examine the response of tomato to Nitrogen and Phosphorus source. The treatments consist, of urea at two levels of application (50kg ha^{-1}and 100kg ha $^{-1}$) and single supper phosphate (SSP), also at two levels of application (60kg ha^{-1} and 180kg ha^{-1}). The experiment design was Randomized Complete Block Design (RCBD) with 3 replicates. Soil samples were collected and analyzed before and after the experiment for soil pH, O: C, N, P, Ca, Mg, K, and Base Saturation. Plant and growth parameter (plant height, numbers of leaves, stem girth, and number of leaves) were collected at two weeks interval. The results were statically analyzed showed. The result of the study indicated that combined use of nitrogen and phosphorus inorganic fertilizer does not have significant positive (P>0.05) effect on tomato growth, yield and soil nutrient after harvesting. The best combination for the combined use of nitrogen and phosphorus inorganic fertilizer tomato growth is 50kg/ha urea + 60kg /ha SSP, while for yield is 10kg/ha urea + 180kg/ha SSP. While 0kg/ha urea + 60kg/ha SSP gave significant (P<0.05) effect in terms of number of leaves, plant height, number of branches, stem girth, number of fruits and weight of fruits.

Keywords: growth parameter, inorganic fertilizer, nitrogen, phosphorus, soil nutrient

I. Introduction

Tomato (*Lycopersicum esculentum*) is important in the diet of man and one of the essential of all vegetables consumed in Nigeria. It is an important condiment in most diet and a very cheap source of vitamin A, B and C (Olaniyi and Ajibola, 2008) large quantities of water, and calcium, all of which are of great importance in the metabolic activities of man (Daneshvar, 2000).

In Nigeria, tomatoes are used in large quantities as compared with other vegetable crops and therefore it becomes imperative that local production be able to meet local consumption. However, this is not the case. This has resulted in high importation of tomato and tomato products to meet the deficit, which has a negative effect on the nation's economy.

Tomato is cultivated under rain fed and in irrigated areas on a wide range of soils. The production in Nigeria often recorded low yield, the low yield experience has been attributed to poor soil fertility and deficiency in important mineral nutrients and most farmers rely mainly on innate fertility of the soil. Soil productivity and fertility can be maintained by the use of soil amendment in form fertilizer (Anonymous, 2005).

Soil fertility depletion in the smallholder farms is the fundamental biophysical root cause for declining per capita food production in sub-Saharan Africa. The area has suffered gross soil nutrient mining due to continuous cropping coupled with low levels of nutrient inputs and poor nutrient conservation practices. The situation is further accentuated by mounting population growth and land scarcity (Smaling, 1993; Mutegi *et al* 2007). Nigeria soil has a high potential for crop production but yield levels obtained under farmer's conditions are usually low due to poor soil management and conservation method.

Fertilizer application is one of the most important factors for obtaining economical yield of tomato. For the plant to grow successfully, tomatoes need nitrogen, phosphorus, potassium, (potash generates potassium, calcium, and magnesium, along with other trace minerals Cooke (1972). Inadequate supply of any of these nutrients during crop growth is known to have negative impact on the reproductive capability, growth and yield of the plant (Vine, 1953; Solubo, 1972). Nitrogen (N) and phosphorus (P) are the two essential macronutrients to crops which improve their growth, yield and product quality (Togun *et al*, 2004; Chen *et al* 2007). Tomato especially needs phosphorus after transplanting. It is better to apply nitrogen and potash during the growth stage of crop. In the tropics, the application of inorganic fertilizers ranges between 40-120kg/ha of nitrogen, 30-90kg/ha potash. Nitrogen support vigorous growth and is essential in photosynthesis, nitrogen equally said to be motor of plant growth (IFA and FAO, 2000), nitrogen is very much essential for good plant establishment and expected growth (Uddin and Khalequzzaman, 2003). Nitrogen enhanced optimum utilization of phosphorus and potassium (). Phosphorus is term the "key of life" because of its direct involvement in most life processes (Amapu, 1998). The importance of phosphorus as an essential nutrient is linked closely to its plant strengthening ability, increase in photosynthetic activities and enzymatic reactions as well as constituent of nucleoprotein and phospholipids in plant cells (Sobulo, 1978). Other vital phosphorus characteristics include fruit formation and quick maturity. Therefore, phosphate fertilization is the only sure way of supplying sufficient phosphorus to crop grown on sub-optimal phosphorus soils. As is the case in other regions in Africa, local farmers use inadequate nutrient inputs, inappropriate quality and inefficient combinations of fertilizers, which in the end prove to be very costly (Palmers *et al* 1997). A consequence of this trend is a deeply unbalanced soil nutrient composition that ultimately leads to a reduction in crop yield potential (Tonfack *et al.*, 2009; Juang, 1995). Application of nitrogen and phosphorus as fertilizer to soils in Nigeria is therefore essential in order to achieve high crop yields of good quality (Upendra *et al.*, 2003). Therefore, the study was conducted to find out the suitable combination of urea (nitrogen) and single super phosphate fertilizers in order to obtain better growth and yield performance of tomato in south western agro-ecological zone of Nigeria.

II. Materials and Methods

The experiment was conducted in 2012 and 2013 cropping season at the Teaching and Research Farm of the Federal University of Technology Akure, Ondo State lies between latitude and longitude. The portion of land for the experiment had been left fallow for one year and was over grown with *Chromoleana odorata*, *Aspilia africana* and *Panicum maximum*. Surface soil samples (0 – 15cm) were randomly collected prior to the commencement of the experiment. Another set of soil samples were taken at crop harvest. The samples comprised of a composite samples of two cores per plot. The soil samples were air-dried sieved to pass through a 2-mm mesh prior to analysis. Particle size as determined by hydrometer method (Bouyocus, 1981), while soil pH was determined in a 1:1 soil to water suspension using a pH meter. Organic carbon was determined by wet oxidation method (Nelson and Sommers, 1982). While total Nitrogen was done by Macro-kjeldahl method and available P by Bray-1 method (Bray and Kurtz, 1945). Exchange bases were extracted with neutral IM NH4OAc at a soil solution ratio of 1:10 and measured by flame photometry. Magnesium was determined with an atomic absorption spectrophotometer. Exchange acidity was determined by titration method (Mclean, 1982).

The experiment was laid out in a randomized complete block designed (RCBD) with three replications. The treatment consists of urea at the rate of 50kg ha^{-1} and 100kg ha^{-1} and single supper phosphate (SSP), at the rate of 60kg ha^{-1} and 180kg ha^{-1}, couple with a combined treatment of urea and SSP, and the control which were applied two (2) weeks after transplanting (WAT).

Roma VF tomato cultivar used was obtained from a local agro input dealer in Akure, Ondo State, Nigeria. The tomatoes seeds were nursed on seed tray. The experimental field was ploughed, harrowed and thereafter made into seed beds. Vigorous tomato seedlings were transplanted onto the field at four weeks after sowing in the nursery. The field was divided into 3 blocks and each block was divided into 9 plots and plants were sown at a spacing of 60 cm x 40 cm between and within rows. All appropriate cultural practices including weeding, watering, staking and insect pest control were timely performed.

Data on plant height, number of leaves, number of branches and stem girth were determined at physiological plant maturity per plot as means of five sampled plants from each plot. Plant height was measured from the base of the plant to the highest point (tip) using a meter tape, while stem girth was determined using digital venier caliper. Number of leaves and branches were determined by visual counting. Fruits were harvested by hand, at the pink stage (calyx attached) every other day in the mornings from each plot. The number and weight of the fruits were counted visually and weighed using digital weighing balance. Data collected were subjected to analysis of variance (ANOVA). Significantly different mean values were separated using least significant different (LSD) at 5% level of probability (Obi, 2001)

III. Results

The result of the pre-planting soil analysis is presented in Table 1. The soil analysis showed moderately acidic conditions (5.21). The soils pH were adequate for producing most crops in the tropics, low in total nitrogen, organic matter (OM), available phosphorus (P), cation exchange capacity (CEC), exchangeable calcium (Ca), potassium (K) and Magnesium (Mg) (Table 1) and the tomato is expected to response positively to the nitrogen and phosphorus source fertilizer treatments.

Table 1 Chemical properties of the soil before planting

Soil Properties	Values
pH (H20)	5.21
N (%)	0.20
P (mg/kg)	3.80
O.C (mg/kg)	1.42
Ca (cmol/kg)	0.65
Mg (cmol/kg)	3.25
Na (cmol/kg)	0.15
K (cmol/kg)	0.43
Al (cmol/kg)	2.60

H^+(cmol/kg)	0.32
Cation Exchangeable Capacity	5.04
Base Saturation (%)	88.89

Table 2 shows that the number of branches produced by tomato plants was significant (P<0.05) influenced by N and P inorganic fertilizer rates. The control plot has the highest number of branches (18.08) while plots treated with 100kg/ha urea + 60kg/ha SSP (15.09) has the lowest number of branch.

Stem girth

Effect of different N and P fertilizer rate on stem girth development is presented in Table 2. The application of urea and SSP fertilizer has significant effect (P<0.05) on the tomato stem girth development compared to control treatment. Tomatoes planted on plots supplied with 0kg/ha urea + 60kg/ha SSP recorded the biggest stem girth (0.73cm) while plots treated with 50kg/ha + 0 SSP recorded the thinnest stem girth (0.50cm).

The results presented in Table 2 illustrated that tomatoes with treated with 0kg/ha urea + 60kg/ha SSP applications recorded the highest number of leaves (10.03) while tomatoes with100kg/ha urea + 180kg/ha SSP application has the lowest number of leaves (7.46). Statistically, application of different rates of Urea and SSP fertilizer combinations had significant (P<0.05) effect of the on number of leaves produced by the tomato plant compared to those planted on plot with no fertilizer application.

Mean plant height of tomatoes planted on plots supplied with different levels of urea and SSP was significant difference (P<0.05). The results showed that plots supplied with 100kg/ha urea + 0kg/ha SSP recorded the highest mean plant height (43.90cm) followed by plots amended with 0kg/ha urea + 60kg/ha SSP (47.32cm) compared with the lowest mean plant height recorded from supplied with 100kg/ha urea + 180kg/ha SSP (30.62).

Table 2: Effects of nitrogen and phosphorus fertilizers on the growth parameters of Tomato

Treatments	Plant height (cm)	Number of branches	Stem girth (cm)	Number of leaves
0kg/ha urea + 0kg/ha SSP	43.01a	18.08a	0.69ab	9.25b
0kg/ha urea +180SSP	40.44ab	17.60abc	0.64bc	8.17c
0kg/ha urea + 60SSP	42.80a	17.81ab	0.73a	10.07a
100kg/ha urea + 0SSP	43.90a	17.36abc	0.59c	9.23b
50kg/ha urea +180SSP	36.85bc	16.05abcd	0.52d	9.16b
50kg/ha urea + 60SSP	35.85bcd	17.38abc	0.61c	9.05b
50kg/ha urea + 0SSP	34.93cd	15.64cd	0.50d	8.23c
100kg/ha urea + 180SSP	30.62d	15.90bcd	0.62c	7.46d
100kg/ha urea + 60SSP	32.15cd	15.09d	0.64bc	8.95 b

Means followed by the same letter in the same column are significantly different from each other by DMRT at 5% level of probability

The effect of combined use of Urea and SSP fertilizer on the number of harvested fruits was significantly different at (P<0.05) (Table 3). The results showed that 0kg/ha urea + 60kg/ha SSP application recorded the highest mean number of harvested fruits followed by 0urea + 0SSP (26.63), 100kg/ha urea + 180kg/ha SSP (24.80) while 0kg/ha urea + 180kg/ha SSP (16.46) and 50kg/ha urea + 180kg/ha SSP (7.63) recorded the least number of fruits. The weight of harvested tomato fruits were equally significantly (p<0.05) influenced by application of different levels of Urea and SSP application. The highest fruit weight was obtained with the application of 0kg/ha urea + 60kg/ha SSP (636.80g) whereas the lowest fruit weight was obtained with the rate 50kg/ha urea + 180kg/ha SSP (169.30g).

Table 3: Effect of combine use of Nitrogen and Phosphorus inorganic fertilizer on number of fruits and weight of fruits

Treatments	No of fruits	Weight of fruits (g)
0urea/ha+0SSP	26.63ab	297.13bc
0urea/ha+180SSP	16.46de	265.50cd
0urea/ha+60SSP	32.46a	636.80a
100urea/ha+0SSP	22.13bc	272.46c
50urea/ha+180SSP	7.63e	169.30e
50urea/ha+60SSP	19.46c	262.80d
50urea/ha+0SSP	18.30cd	190.30de
100urea/ha+180SSP	24.80b	488.30ab
100urea/ha+60SSP	17.80d	317.13b

Result of post cropping soil analysis (Table 4) indicated that using combine urea and SSP fertilizers had significant effect (p<0.05) on soil pH, organic carbon, P, K, Na, Mg, Ca, Al, H, CEC and Base saturation. Soil pH's continuously decreased in treatments with 0urea/ha + 60SSP > 100urea/ha+0SSP > 50kg/ha urea+180kg/ha SSP > 50kg/ha urea+60kg/ha SSP > 50kg/ha urea+ 0kg/ha SSP fertilizer application. An increase in soil pH was observed in plots with no fertilizer application, 50kg/ha urea + 60kg/ha SSP and 0urea/ha + 180SSP. Treatment with no fertilizer application (5.86) and 0kg/ha urea+ 180kg/ha SSP (5.72) had the highest soil pH. The soil can be classified as acid, and slightly acidic. Soil organic carbon decreased in all the treatments; and can be classified as low in organic carbon, and moderate in CEC. Soil P increase in all the treatments except in control plots and 50kg/ha urea + 60kg/ha SSP. Soil potassium decreased significantly in all the treatments.

The result presented in table 4 also show that the combine use of urea and SSP significantly caused the soil Na at crop maturity to increase in all the treatments with treatment 50kg/ha urea + 0kg/ha SSP having the highest soil Na. Therefore, the soil can be classified as low in Na. Likewise, soil Ca and Mg decreased significantly across the treatments at crop maturity excluding treatment with no application and 0kg/ha urea + 60kg/ha SSP. The soil is classified as being low in Ca and high in Mg. The effect of the treatments was significant on the soil Al after harvesting. The soil Al decreased in 0kg/ha urea+0kg/ha SSP > 0urea/ha+180SSP > 100urea/ha+0SSP > 50urea/ha+180SSP and

50urea/ha+0SSP while it remain unchanged in 0kg/ha urea+60kg/ha SSP and 100kg/ha urea +180kg/ha SSP. The soil Al increased in 50kg/ha urea+60kg/ha SSP and 100kg/ha urea+60kg/ha SSP. The effect of the treatments was significant on the soil H after harvesting. The soil H across all treatments remaining the same in 0kg/ha urea+180kg/ha SSP and 100kg/ha urea+0kg/ha SSP. 100kg/ha urea+180kg/ha SSP and 50kg/ha urea+60kg/ha SSP had the highest soil H of 0.44 after harvesting. The soil CEC was significantly affected by the urea and SSP treatments. The soil CEC increased with the application of all the treatments at crop maturity 0kg/ha urea+ 60kg/ha SSP had the highest CEC value. There was significant effect of the treatments on the soil base saturation crop maturity. The base saturation of the soil decreased across the treatments after harvesting. 0kg/ha urea+ 0kg/ha SSP had the highest base saturation of 65.44, while 100kg/ha urea + 180kg/ha SSP had the lowest base saturation of 53.64 after harvesting.

Table 4: Effect of combine use of Nitrogen and Phosphorus inorganic fertilizer on the soil chemical properties after harvesting

Treatments	pH (h_20)	OC (g/kg)	N (%)	P (mg/kg)	K (cmol/kg)	Na (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)	Al (cmol/kg)	H (cmol/kg)	CEC (meg/kg)	B (%)
0u+0ssp	5.86a	1.34a	0.13c	3.58f	0.29c	0.18c	0.67b	3.33b	2.00b	0.36b	6.83b	65.44a
0u+180ssp	5.72b	1.12c	0.13c	4.12e	0.29c	0.18c	0.63c	3.17c	2.00b	0.32c	6.59cd	64.80ab
0u+60ssp	5.16d	0.96g	0.15c	13.61b	0.34b	0.17d	0.72a	3.58a	2.40ab	0.40ab	7.61a	63.00b
100u+0ssp	4.56f	0.84h	0.12c	3.58f	0.25f	0.16e	0.63c	3.17c	2.20b	0.32c	6.73bc	62.56bc
50u+180ssp	4.19h	1.02f	0.15c	13.69a	0.37a	0.16e	0.53e	2.67e	2.20b	0.36b	6.29d	59.30cd
50u+60ssp	5.53c	0.82i	0.15c	2.33g	0.22g	0.19b	0.57d	2.83d	2.60a	0.44a	6.85ab	55.62d
50u+0ssp	4.07i	1.06e	0.31a	11.74c	0.34b	0.21a	0.52f	2.58f	2.00b	0.36b	6.01e	60.73c
100u+180ssp	4.53g	1.10d	0.16c	7.47d	0.27e	0.17d	0.47g	2.33g	2.40ab	0.40ab	6.04de	53.64e
100u+60ssp	4.62e	1.24b	0.20b	4.12e	0.28d	0.17d	0.53e	2.67e	2.60a	0.44a	6.69c	54.55de

IV. Discussion

This study revealed that Urea and SSP fertilizer applications are very essential for enhancing and maintaining soil nutrient status. According to the experimental results of soil analysis on Table 2, soil chemical characteristics crop maturity for few treatments increased slightly and dropped a little for most treatments. The soil pH increased in treatment 0kg/ha urea + 0kg/ha SSP, 0kg/ha urea + 180kg/ha SSP, 0kg/ha urea + 60kg/ha SSP and 50kg/ha urea + 60kg/ha SSP from 5.21 before planting to 5.86 and decreased in other treatments at crop maturity. This suggest that SSP does not contribute to reduction in soil pH as opposed to urea fertilizer and combine use urea and SSP fertilizers that decreases the pH of the soil. More so, the soil organic carbon and K level dropped significantly ($p<0.05$) in all the treatments at crop maturity. These may be as a result of the use of only inorganic nutrient source and lack of application of potassium containing fertilizer. Contrarily to the decrease in organic carbon (OC) and potassium (K), the soil sodium (Na) and magnesium (Mg) increased significantly in all the treatments at crop maturity. The base saturation decreased in all the treatments. The control plot had the highest base saturation while plants with 100kg/ha urea + 180kg/ha SSP had the lowest base saturation at crop maturity. This means urea and SSP fertilizers significantly decrease the soil base saturation especially with high application rates.

The soil status before planting through the soil analysis indicated that the soil is quite fertile and can sustain good growth and yield of tomato. The good condition of the soil contributes to the good performance of the treatment without any fertilizer application even more than most of that treated with combine use nitrogen and phosphorus inorganic fertilizer. Observation from this study also showed that the soil fertility was not depleted i.e. not notably reduced, after harvesting in treatment without fertilizer application.

The effect combine use of urea and SSP fertilizer was significant ($p<0.05$) for all growth and yield parameters considered in this study. The result presented in Table 2 showed that increase in the combine use of urea and SSP fertilizers decrease tomato growth and yield significantly ($p<0.05$) Phimmasone (2011) reported that the increase in the use of inorganic fertilizer or over fertilization results in significant ($p<0.05$) decrease in tomato growth, yield, plant nutrient uptake, and nutrient efficiency. heavy application of inorganic fertilizer can result in long term soil fertility though they start depositing their harmful effects to the soil quality and crop production. Either reason according to yield will be severely reduced when a nutrient concentration increases toward excessive absorption of nutrient can be toxic to plant and reduce yield. Singly application of Nitrogen (100kg/ha urea + 0kg/ha SSP) and Phosphorus (0kg/ha urea + 60kg/ha SSP) inorganic fertilizer produce the best result in terms of vegetative growth and yield. Combine use of N and P inorganic fertilizer at (100kg/ha urea + 180kg/ha SSP) give the best result second to (0kg/ha urea + 60kg/ha SSP) the efficiency of nutrient uptake depends on both the supply of nutrient in the correct quantity and timing in relation to the crop demand and ability of the crop to take up the available nutrient. Generally, tomatoes with 50kg/ha urea + 180kg/ha SSP application performed poorly especially in terms of yield while 0kg/ha urea + 60kg/ha SSP appear to be the best application rate.

V. Conclusion

The best combination for the combined use of urea and SSP fertilizer application on tomato growth is 50kg/ha urea + 60kg/ha SSP, while that of yield is 100kg/ha urea + 180kg/ha SSP. 0kg/ha urea + 60kg/ha SSP performs best in this study. It improves plant height, number of branches, stem girth, numbers of leaves, number and weight of fruits. Sequel to the findings from this study soil amendment with urea and SSP fertilizer application is recommended for optimum crop productivity of tomato cultivation in south western Nigerian agro ecological zone.

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