# Effects of NPK Fertilizers on the Growth, Yield and Chemical Content of Tomato (*Lycopersicon esculentum* L. Mill)

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**Abstract** This paper investigates the effect of NPK fertilizers with different content of nitrogen on growth, yield and chemical content of tomato (*Lycopersicon esculentum* L. Mill). NPK fertilizers were used based on polyvinyl alcohol (P) blended with three different contents of urea (U) (PU35, N: 8.45%; PU50, N: 34.1%, and PU65, 44.04%) and $K_3PO_4$. NPK35, NPK50 and NPK65 fertilizers were prepared by mixing 90% PU with 10% $K_3PO_4$. All treatments were applied at the rate of 500 ml (1% w/v) of NPK directly to the soil. The first treatment was given at 15-day-old seedlings. Thereafter, the treatments with 5 replications were given at intervals of 15 days (6 s) each until 90 days. Final harvest was at 112 days. Data was analyzed using variance analysis (ANOVA) and compared using control without fertilizer. The results indicate that the NPK fertilizers cause improvement in the vegetative growth, yield as well as chemical content of tomato plants. Meanwhile, the application of NPK fertilizer (NPK50) with nitrogen content 31.7% increased the above parameters more than NPK35, NPK65 and control.

**Keywords** NPK · Fertilizers · Tomato · Growth · Yield · Nitrogen

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## 1 Introduction

Tomato (L*ycopersicon esculentum* Mill.) is a very popular vegetable grown in the world [1]. A number of researchers focus on increment tomato yield by introducing new NPK fertilizers [2]. The application of NPK fertilizers to tomato plants at proper times with suitable rates could increase yield of tomatoes. Authors found that increasing NPK levels resulted in higher growth performance in tomato varieties [3]. A high concentration of NPK in the nutrient solution gave higher total yield and tomato fruit weight than the control nutrient solution [4]. It was reported that fertilizing tomato with NPK at deferent levels increased the vegetative growth characters, for example moderate dose of NPK (N: 26.7 g, P: 10.0 g and K: 53.3 g/$m^2$) significantly increased tomato growth and yield [5, 6]. The highest plant height, the maximum number of primary and secondary branches, number of flowers and fruits per plant as well as the greatest fruit size, fruit yield per plant and fruit tomato yield per ha were obtained when NPK fertilizer was applied at the rates of 120 kg N, 80 kg P and 75 kg K/ha [7]. The application of NPK at the rate of 20:10:10 has a highly significant effect on the growth and yield of tomato varieties and enhanced the soil chemical parameters [8]. Pansare et al. [9] studied the effect of NPK on yield and quality of tomato and evaluated the maximum yield of high-quality tomato when N, P and K fertilizers were added at a ratio of 3:1:2 (150 kg N/ha, 50 kg P/ha, and 100 kg K/ha). However, the application of NPK at rates of 60 kg N/ha, 50 kg $P_2O_5$/ha and 33 kg $K_2O$/ha gave the highest growth, and fruit yield of tomato as compared to control without fertilizers [10]. Felipe and Casanova [11] investigated the effects of N (0, 90, 180 and 270 kg/ha), P ($P_2O_5$, 0, 135, 270 and 405 kg/ha), and K ($K_2O$, 0, 90, 180 and 270 kg/ha) on the yield and number of fruits of tomato in Venezuela [11]. The best treatment, with the highest yield and number of fruits per plant, was 180 kg N, 270 kg $P_2O_5$, and 180 kg $K_2O$/ha. The present study was undertaken to improve growth, yield and chemical Content of Tomato (*Lycopersicon esculentum* L. Mill) fertilized with NPK at different rates NPK35 (N: 7.8, P: 5.7, K: 4.8%), NPK50 (N: 31.7, P: 4.05, K: 4.6%) and NPK65 (N: 40.3, P: 4.5, K: 5.1%).

## 2 Material and Method

### *2.1 Synthesis of Nitrogen Fertilizer (PU)*

The nitrogen fertilizers based on polyvinyl alcohol (PVA) with urea (U) were synthesized with composition ratios i.e. 65:35 (PU35), 50:50 (PU50) and 35:65 (PU65) respectively by blending polymerization in presence of acetic acid as catalyst. The preparation of nitrogen fertilizer and the method of analysis ($^1$H NMR, FTIR, SEM, DSC and TGA) have been previously described in a previous investigation by Negim et al. [12]. The elemental analysis was carried out for the determination of carbon,

**Table 1** Elemental composition of nitrogen fertilizer (PU)

| Elements | C (%) | N (%) | O (%) |
|---|---|---|---|
| PU35 | 49.41 | 8.45 | 42.15 |
| PU50 | 28.79 | 34.09 | 37.58 |
| PU65 | 21.54 | 44.04 | 34.42 |

**Table 2** Elemental composition of NPK fertilizers

| Elements | C (%) | N (%) | O (%) | P (%) | K (%) |
|---|---|---|---|---|---|
| NPK35 | 39.05 | 7.8 | 42.7 | 5.7 | 4.8 |
| NPK50 | 26.8 | 31.7 | 33.1 | 4.05 | 4.6 |
| NPK65 | 19.9 | 40.3 | 31.09 | 4.5 | 5.1 |

nitrogen and oxygen content in the fertilizers as shown in Table 1. The analysis was performed on a Vario Micro Elemental Analyzer (Elementar, Germany).

## *2.2 Preparation of NPK Fertilizer*

NPK fertilizers were prepared by mixing 90% PU35, PU50 and PU65 with 10% $K_3PO_4$. The elemental analysis of NPK fertilizers was performed on a Vario Micro Elemental Analyzer (Elementar, Germany) as shown in Table 2.

NPK fertilizers were used with a constant concentration of 1% w/v using distilled water.

## *2.3 Experimental Design and Treatments*

The crop plant selected for the present study was *Lycopersicon esculentum* (tomato). The hybrid tomato seeds (Pearl-F1) were purchased from the local market and kept for one hour in a glass beaker with fresh water. Only the seeds that settled at the bottom of the beaker were used for conducting the experiment. The seeds were carefully sowed in plastic trays and regular sprinkling of water was done to keep the compost soil moist. After two weeks, the germinated seedlings were transferred and planted in plastic pots. The seedlings were pushed 5 cm deep into the soil and the depression was then loosely covered back by the soil. The soil was air-dried, sieved and packed (13.5 kg/pot), and was properly filled in 15 pots. Each pot was labelled with the pot number and the date of sowing of the seeds were recorded to determine the offset date for analysis. The day on which the seedlings were planted

**Fig. 1** Tomato plants after two weeks of germination

in the pot was treated as day zero (Fig. 1). The plants were watered every day or on alternate days depending on the requirement. All 3 sets were prepared in five replicates. Nitrogen fertilizer treatment was given to the plants namely PU and a set of control pants. In each of the treatment, 500 mL (1% w/v) of PU was applied directly to the soil. The first treatment was given at 15-day-old seedlings. Thereafter, the treatments were given at intervals of 15 days each until 90 days. The control set was watered only with tap water without any fertilizers.

## *2.4 Physical and Chemical Properties of the Soil*

In this study, the soil physical and chemical properties were analyzed before the addition of the N-fertilizer (PU) in different concentrations to the experimental soil to know the type and properties of the soil. The result is as presented in Table 3.

**Table 3** Physical and chemical properties of the soil

| | |
|---|---|
| *Physical properties* | |
| Sand | 56.63 (%) |
| Silt | 24.15 (%) |
| Clay | 14.22 (%) |
| Soil texture | Sandy loam |
| *Chemical properties* | |
| pH | 7.8 |
| Ec | 1.4 (mhos/cm$^3$) |
| Available N | 81.0 (ppm) |
| Available P | 3.04 (ppm) |
| Available K | 40.8 (ppm) |
| Organic matter | 0.6 (%) |

The ingredients of the experimental soil were a mixture of clay (56.63%), fine sand (14.22%), and silt (24.15%). The chemical properties of the soil were 1.4 mhos/cm$^3$, 81.0 ppm N, 3.04 ppm P, 40.8 ppm K, 0.6 ppm of organic matter and pH was 7.8.

## *2.5 Data Recorded*

**Vegetative growth** Plant height, number of main lateral branches, number of leaves, leaf area as well as fresh and dry weights of shoots were recorded at 4 and 8 weeks.

**Chemical composition** Leaves disks were taken at 4 and 8 weeks after transplanting to determine chlorophyll a, b according to the method described by Sartory and Grobbelaar [13]. Total carbohydrate content in dry matter of leaves was determined spectrophotometrically method described by Dubois et al. [14]. Nitrogen, phosphorus and potassium elements were determined in the leaves of tomato plants via digestion procedure according to Piper [15]. Nitrogen content was determined by modified micro-Kjeldahl method as described by Pregl [16]. Phosphorus and potassium contents in the sample were estimated using ammonium molybdate and flame photometer methods respectively, according to Chapman and Pratt [17].

**Flowering and fruit yield** Node number bearing the first flower, number of flower clusters per plant, number of flowers per cluster, number of flowers per plant, weight and number of fruits per plant were recorded.

**Physical characteristics of fruits** Fruit shape index was calculated using the ratio of vertical to horizontal diameters. Fruit volume was determined by using immersion method.

**Chemical characteristics of fruits** Soluble solids content (SSC) was determined by hand refractometer according to the method described by AOAC [18]. Titratable acidity was determined using the method described by AOAC [19] and AOAC [20]. Ascorbic acid content (vitamin C) was determined as described by AOAC [20]. Lycopene in the tomato samples was extracted with hexane: ethanol: acetone (2:1:1) (v/v) mixture following the method of Sharma and Le Maguer [21].

## *2.6 Statistical Analysis*

The data calculated on different variables were subjected to analysis of variance (ANOVA) to observe the differences among the treatments and their interactions. Means were separated using Least Significant Difference (LSD at 5%) test. Statistical computer software "Statistix 8.1" was used for computing the ANOVA and LSD Mead et al. [22].

**Table 4** The effect of NPK fertilizers on the growth vegetative characteristics of tomato plant

| Treatments | Plant height (cm) | | Number of lateral branches/plant | | Number of leaves/plant | |
|---|---|---|---|---|---|---|
| | 4 weeks | 8 weeks | 4 weeks | 8 weeks | 4 weeks | 8 weeks |
| Control | $84.83^{d}$ | $118.32^{d}$ | $18.88^{c}$ | $32.70^{d}$ | $43.50^{c}$ | $97.70^{d}$ |
| NPK35 | $96.35^{b}$ | $139.76^{b}$ | $19.70^{c}$ | $47.42^{c}$ | $50.63^{b}$ | $111.42^{b}$ |
| NPK50 | $101.05^{a}$ | $142.50^{a}$ | $25.65^{a}$ | $57.50^{a}$ | $60.96^{a}$ | $117.53^{a}$ |
| NPK65 | $90.53^{c}$ | $131.65^{c}$ | $22.58^{b}$ | $51.65^{b}$ | $48.50^{b}$ | $101.15^{c}$ |
| LSD 0.05 | 1.7886 | 1.61125 | 1.0898 | 0.9882 | 2.3742 | 1.7421 |

a, b, c and d = Statistical Analysis

## 3 Results and Discussion

### *3.1 Plant Height (cm)*

The effect of NPK fertilizer treatment with varied concentrations of NPK on tomato plant height is shown in Table 4. The results indicated that the NPK fertilizers had a positive effect on the plant height compared to control. The plants fertilized with NPK50 gave the tallest plants with 101.05 and 142.5 cm at 4 and 8 weeks respectively, while plants fertilized with NPK65 showed height of 90.53 and 131.65 cm at 4 and 8 weeks respectively. The increase of plant height of tomatoes by NPK might be due to tomato plants being feeders for macronutrient elements including potassium (K), nitrogen (N) and phosphorus (P) [23]. Authors demonstrated that tallest plants of tomato were obtained from the plots treated with NPK fertilizer compared to the control [24, 25].

### *3.2 Number of Lateral Branches*

The effect of different concentrations of NPK fertilizers on the number of lateral branches per tomato plant at 4 and 8 weeks is shown in Table 4. Number of lateral branches per plant fertilized with NPK was higher than control at 4 and 8 weeks of treatment. However, Plants fertilized with NPK50 (N: 31.7, P: 4.04, K: 4.6%) increased number of lateral branches to 57.5% at 8 weeks, while plants fertilized with NPK35 (N: 7.8, P: 5.7, K: 4.8%) increased lateral branches per plant to 45.0.02% at 8 weeks. The increase in number of lateral branches could be attributed to increased nitrogen content in NPK fertilizer. This result is in agreement with Manoj et. al. [7], whereby increasing levels of nitrogen in NPK resulted in 30% increase of lateral branches per tomato plant.

### 3.3 Number of Leaves Per Plant

The greatest number of leaves per plant was observed when level of N increased from 7.8% to 31.7% in NPK fertilizers. At 4 and 8 weeks of treatment, the NPK50 (N: 31.7, P: 4.04, K: 4.6%) resulted in the greatest number of leaves per plant (60.9 and 117.5 respectively) followed by NPK35 (N: 7.8, P: 5.7, K: 4.8%) (50.6 and 111.4 respectively) and NPK65 (N: 40.3, P: 4.5, K: 5.1%) (48.5 and 101.2 respectively) (Table 4). These values indicated significant response to the NPK fertilizers treatment and difference of nitrogen levels in the NPK had considerable influence on the number of leaves per plant [26]. These results were in agreement with those of Adekiya and Agbede [27]. The lowest value of leaf number was calculated for the control plants at 4 and 8 weeks (43.5 and 97.7 respectively).

### 3.4 Leaf Area ($cm^2$)

The effect of NPK fertilizer on leaf area of tomato at 4 and 8 weeks is shown in Table 5 whereby the fertilizer highly induced an increase in the leaf area over the control plants. These results indicated that NPK had a favourable effect on leaf area. The highest record of leaf area was obtained from plants fertilized with NPK50 (N: 31.7, P: 4.04, K: 4.6%), while control without fertilizer gave the lowest leaf area at 4 and 8 weeks. This attributed to role of nitrogen in NPK fertilizer which increasing cytokinin in the shoots and increasing leaf area. Similar results were recorded by Singh et al. [28] who found that NPK treatments significantly increased leaf tomato area.

**Table 5** The effect of NPK fertilizers on the growth vegetative characteristics of tomato plant

| Treatments | Leaf area ($cm^2$) | | Shoots fresh weight (g/plant) | | Shoots dry weight (g/plant) | |
|---|---|---|---|---|---|---|
| | 4 weeks | 8 weeks | 4 weeks | 8 weeks | 4 weeks | 8 weeks |
| Control | $138.53^{d}$ | $151.90^{d}$ | $227.50^{d}$ | $350.40^{d}$ | $60.38^{c}$ | $85.75^{d}$ |
| NPK35 | $220.35^{c}$ | $250.00^{c}$ | $272.18^{b}$ | $625.20^{b}$ | $69.10^{b}$ | $131.38^{b}$ |
| NPK50 | $259.20^{a}$ | $277.78^{a}$ | $298.37^{a}$ | $877.78^{a}$ | $75.90^{a}$ | $201.43^{a}$ |
| NPK65 | $245.40^{b}$ | $263.00^{b}$ | $252.23^{c}$ | $543.10^{c}$ | $61.35^{c}$ | $111.20^{c}$ |
| LSD 0.05 | 1.4744 | 1.5031 | 1.0508 | 0.6722 | 1.0873 | 1.2683 |

a, b, c and d = Statistical Analysis

### 3.5 Fresh and Dry Weight of Shoots (g/Plant)

All applications of NPK fertilizers had a significant effect on the fresh and dry weights of shoots than control at 4 and 8 weeks. The fresh and dry weights of shoots tomato plants treated with NPK50 (N: 31.7%) were higher than NPK35, NPK65 and control at both 4 and 8 weeks (Table 5). NPK50 increased fresh shoot weight and dry shoot weight up to 150.15% and 134.8% respectively at 8 weeks, compared to control. While, NPK65 increased fresh shoot weight and dry shoot weight up to 54.99% and 29.67% respectively at 8 weeks. The increase in fresh and dry shoot weight might be due to that NPK improved root growth, which consequently promoted shoot growth. A similar result has been results reported by Etissa et al. [29] who demonstrated that fresh and dry weights of tomato shoots were affected by the application of NPK fertilizer.

### 3.6 Chlorophyll (a, b) Content (mg/dm$^2$)

The effect of NPK fertilizers containing different ratios of nitrogen on the chlorophyll a and b contents in the tomato leaves at 4 and 8 weeks is presented in Table 6. The results showed that chlorophylls content increased in all the tomato plants treated with NPK fertilizers. The maximum content of chlorophylls a and b (2.915 and 1.873 mg/dm$^2$ respectively) was recorded in plants that were fertilized with NPK50 (N: 31.7, P: 4.04, K: 4.6%) at 8 weeks while the minimum content of chlorophylls a and b content (2.2 and 1.4 mg/dm$^2$ respectively) was recorded in plants that were fertilized with NPK65 (N: 40.3, P: 4.5, K: 5.1%) at 8 weeks. Leaf chlorophyll content was found to be affected by different factors including types and concentration of fertilizers, nutrient concentration, distribution of chlorophyll in leaves and plant genotype [30].

**Table 6** The effect of NPK fertilizers on chlorophyll a, b (mg/dm$^2$) and carbohydrate content (%) in leaves of tomato plant

| Treatments | Chlorophyll a (mg/dm$^2$) | | Chlorophyll b (mg/dm$^2$) | | Carbohydrate (%) | |
|---|---|---|---|---|---|---|
| | 4 weeks | 8 weeks | 4 weeks | 8 weeks | 4 weeks | 8 weeks |
| Control | 1.20$^d$ | 1.44$^d$ | 0.64$^d$ | 0.84$^d$ | 9.55$^d$ | 12.56$^c$ |
| NPK35 | 1.94$^b$ | 2.55$^b$ | 0.78$^c$ | 1.19$^c$ | 11.32$^b$ | 13.75$^b$ |
| NPK50 | 2.52$^a$ | 2.92$^a$ | 1.47$^a$ | 1.87$^a$ | 12.65$^a$ | 16.75$^a$ |
| NPK65 | 1.72$^c$ | 2.16$^c$ | 0.89$^b$ | 1.39$^b$ | 10.63$^c$ | 12.63$^c$ |
| LSD 0.05 | 0.0843 | 0.0631 | 0.0283 | 0.0401 | 0.2999 | 0.2222 |

a, b, c and d = Statistical Analysis

### 3.7 Carbohydrate Content (%)

Table 6 shows the response of total carbohydrate of tomato leaves to NPK fertilizers. It can be seen that NPK fertilizers significantly increased the total carbohydrate percentage in the treated plants over the control. The highest carbohydrate contents in tomato leaves were obtained with NPK50 fertilizer (16.75%), while the lowest carbohydrates content was observed in plants fertilized with NPK65 fertilizer (12.63%) at 8 weeks. This is attributed to the increase in the rate of photosynthesis process and construction of organic compounds mainly carbohydrates as reported by Xiukang and Yingying [31].

### 3.8 Nitrogen, Phosphorus and Potassium Content (%)

The nutrient percentage in leaves of tomato plants as influenced by NPK fertilizers in both 4 and 8 weeks is shown in Table 7. All NPK fertilizer treatments enhanced the absorption of N, P and K, hence increased the concentrations in the leaves as compared to the control plants. The highest leaf nitrogen content was the plant fertilized with NPK65 (N: 40.3, P: 4.5, K: 5.1%) whereas the highest concentrations of P and K were detected in the leaves treated with NPK 50 (N: 31.7, P: 4.04, K: 4.6%) at 4 and 8 weeks. The highest P content (0.65%) and K content (2.85%) in leaves of tomato plants were observed in NPK50 fertilizer and the lowest P content (0.44%) in leaves was found in NPK 65 fertilizer at 8 weeks, while the lowest K content (2.4%) was in NPK35 fertilizer at 8 weeks. The increase in nutrient percentage in leaves of tomato plants maybe due to improved absorption of N, P and K at higher rates of application and is consistent with the use of NPK as fertilizers for tomato production [27].

**Table 7** The effect of NPK fertilizers on the chemical composition in leaves tomato at 4 and 8 weeks

| Treatments | Nitrogen, (%) | | Phosphorus, (%) | | Potassium, (%) | |
|---|---|---|---|---|---|---|
| | 4 weeks | 8 weeks | 4 weeks | 8 weeks | 4 weeks | 8 weeks |
| Control | $2.27^{d}$ | $3.29^{d}$ | $0.23^{c}$ | $0.41^{d}$ | $1.41^{c}$ | $1.94^{d}$ |
| NPK35 | $3.90^{c}$ | $4.42^{c}$ | $0.44^{b}$ | $0.53^{b}$ | $1.82^{b}$ | $2.43^{c}$ |
| NPK50 | $4.21^{b}$ | $5.75^{b}$ | $0.49^{a}$ | $0.56^{a}$ | $2.00^{a}$ | $2.85^{a}$ |
| NPK65 | $5.13^{a}$ | $6.67^{a}$ | $0.43^{b}$ | $0.44^{c}$ | $1.87^{b}$ | $2.66^{b}$ |
| LSD 0.05 | 0.165 | 0.2593 | 0.0296 | 0.0312 | 0.0602 | 0.0446 |

a, b, c and d = Statistical Analysis

**Table 8** The effect of NPK fertilizers on flowering characteristics of tomato plant

| Treatments | Node number bearing | Number of flower clusters/plant | Number of flowers/cluster | Number of flowers/plant |
|---|---|---|---|---|
| Control | 5.50[d] | 14.11[d] | 4.35[d] | 75.40[c] |
| NPK35 | 7.24[c] | 21.65[b] | 6.19[c] | 87.55[b] |
| NPK50 | 8.63[a] | 28.69[a] | 8.21[a] | 99.64[a] |
| NPK65 | 8.08[b] | 19.96[c] | 7.40[b] | 84.40[b] |
| LSD 0.05 | 0.2754 | 0.1994 | 0.2846 | 3.3503 |

a, b, c and d = Statistical Analysis

## *3.9 Characteristics of Flowers*

The influences of NPK fertilizer on flowering of tomato plants are shown in Table 8. Data revealed that the NPK improved the flowering characters. Increasing N content in NPK from 7.8% (NPK35) to 31.7% (NPK50) increased the node number bearing the first flower from 7.24 to 8.63, number of flower clusters per plant from 21.65 to 28.69, number of flowers per cluster from 6.19 to 8.21, and number of flowers per plant from 87.55 to 99.64. It might be due to the highest level availability nutrients to plant that forced towards the growth of vegetative parts then bloom as compared to control without fertilizers. Similar results were obtained by authors [3, 28] who detected similar flowering characteristics of tomato plants treatment with NPK fertilizers.

## *3.10 Characteristics of Fruits*

**Number of fruits per plant** Tomato plants treatment with NPK produced a higher number of fruits than the control as shown in Table 9. The maximum fruit numbers were produced by plants fertilized with NPK50 (N: 31.7%) (35.7) and NPK35 (N: %) (31.4) compared to plants fertilized with NPK 65 (N: 40.3%) (28.8) and control

**Table 9** Effect of NPK fertilizers on fruit numbers and physical characteristics of tomato fruits

| Treatments | Fruit number/plant | Fresh weight (g/fruit) | Shape index | Fruit volume ($cm^3$) |
|---|---|---|---|---|
| Control | 24.25[d] | 37.24[d] | 1.10[d] | 32.08[d] |
| NPK35 | 31.38[b] | 75.45[b] | 1.25[b] | 40.53[b] |
| NPK50 | 35.65[a] | 82.93[a] | 1.41[a] | 44.94[a] |
| NPK65 | 28.80[c] | 71.60[c] | 1.81[c] | 37.74[c] |
| LSD 0.05 | 0.3408 | 0.4701 | 0.0582 | 0.2017 |

a, b, c and d = Statistical Analysis

(24.3). These results agreed with Zekri and Obreza [32] who stated that lower concentrations of NPK limited plant growth, flower and fruit production of citrus. Increasing the nitrogen content in NPK increased the number of fruits due to the increased vegetative growth under abundance of nitrogen content in NPK for photosynthesis activity.

**Weight and volume of fruits** The data presented in Table 9 demonstrates that NPK treatment of tomato plants had significant effects on fresh weight, volume and shape index of the tomato fruit. Plants treated with NPK50 (N: 31.7, P: 4.05, K: 4.6%) showed the highest fruit weight (82.9 gm), volume (44.9 $cm^3$) and shape index (1.4), while plants fertilized with NPK65 (N: 40.3, P: 4.5, K: 5.1%) showed the lowest values of the above parameters (71.6 gm, 37.7 $cm^3$ and 1.2 respectively) but higher than the control. The findings of Fandi et al. [4] and Schon et al. [33] supported these results whereby increased weight of the tomato fruit parameters was attributed to the nutrient potential of the NPK fertilizer.

## *3.11 Chemical Composition of Fruits*

The SSC, acidity, ascorbic acid and lycopene of fruits tomato plants treated with NPK is shown in Table 10. The SSC, titratable acidity of fruits increased with increasing nitrogen content in NPK up to 31.7% (NPK50). Beyond 31.7% (NPK65) the SSC, titratable acidity began to decrease but still higher than control fruits as shown in Table 10. Table 10 indicates that NPK treated plants produced fruits with higher ascorbic acid and lycopene than the control plants. Treatment with NPK 50 (N: 31.7, P: 4.05, K: 4.6%) gave the highest values for all the chemical characteristics of the tomato fruits. The increase in SSC, titratable acidity, ascorbic aci, lycopene of tomato fruits might be attributed to the effect of NPK in supplying the plants with various nutrients, and producing auxins (Mansour et al. [35]). These results were consistent with those of Xiukang and Yingying [31], Salama et al. [34], and Mansour et al. [35]. who illustrated that plant grown at high nitrogen content will result in fruits

**Table 10** Effect of NPK fertilizers on some chemical characteristics of tomato fruits

| Treatments | Soluble solids content (%) | Titratable acidity (%) | Ascorbic acid content (mg/100 g) | Lycopene (mg/100 g) |
|---|---|---|---|---|
| Control | $3.60^{d}$ | $0.65^{d}$ | $17.18^{d}$ | $25.08^{d}$ |
| NPK35 | $5.71^{b}$ | $0.76^{b}$ | $20.30^{b}$ | $35.81^{b}$ |
| NPK50 | $6.10^{a}$ | $0.87^{a}$ | $22.91^{a}$ | $37.48^{a}$ |
| NPK65 | $5.19^{c}$ | $0.71^{c}$ | $18.77^{c}$ | $32.90^{c}$ |
| LSD 0.05 | 0.3292 | 0.0425 | 0.265 | 0.0593 |

a, b, c and d = Statistical Analysis

with high SSC, titratable acidity, ascorbic aci, lycopene and tomato fruits responded mainly to NPK fertilization (15: 15: 15).

## 4 Conclusions

NPK fertilizer treatments were carried with the aim of improving tomato growth and yield, and leaf chemical composition. NPK fertilizers were based on mixing 90% PU fertilizer with 10% $K_3PO_4$, with different nitrogen content NPK35 (N: 7.8, P: 5.7, K: 4.8%), NPK50 (N: 31.7, P: 4.05, K: 4.6%) and NPK65 (N: 40.3, P: 4.5, K: 5.1%). Data on plant height, number of lateral branches, number of leaves per plant, leaf area, fresh and dry weights of shoots, chlorophylls a and b; carbohydrate content, nutrient content, node number bearing the first flower, number of flower clusters per plant, number of flowers per cluster, number of fruits, weight, volume and shape index of fruits, soluble solid content (SSC), acidity, vitamin C, and lycopene pigment were recorded and statistically analyzed to evaluate the treatment effects. Results revealed that growth in tomato was more highly influenced by NPK treatments. However, the highest vegetative growth, fruit yield, nutrient content in the fruit content were found in tomato plants fertilized with NPK50 (N: 31.7%) followed by NPK35 (N: 7.8%) and NPK65 (N: 40.3).

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