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# Effect of Soil Amendment with Neem Seed Cake on Tomato Plant Growth and Development, Fruit Quality and Storability

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**Abstract:** In Cameroon, most of tomatoes (*solanum lycopersicum)* are produced in the Western Highlands. During the period of production peaks farmers are faced with enormous postharvest losses. Furthermore, necessary great quantities of chemical inputs are some of potential threats to fruits quality and the environment. Since events occurring in the field finally impact the quality and storability of agricultural produces, the present study aimed at improving these parameters through soil amendment with neem seed cake (NSC) as bioeffector while preserving the environment. The NSC was therefore used at four doses (0 g, 4 g, 8 g and 12 g per plant). The experiment was carried out in a complete randomized block design with six repetitions in each treatment. Treatments began at the 2nd week after seedling transplantation and were continued at three weeks intervals. The plant growth and development, fruit quality and storability parameters were determined. The plant height, stem diameter, number of leaves per plant, number of branches per plant, time elapsed between the seedling transplanting date and the date of the appearance of the first flower, number of flower buds per plant, number of flowers per plant, number of grapes per plant, number of fruits per plant, fruit physiological weight loss (PWL), fruit titratable acidity (TA) and fruit senescence rate were positively influenced by the soil application of NSC, the dose of 12g/plant having been the most efficacious. The increase in TA was an indication of an improvement of the quality whereas the reduction of the PWL and the decrease in the rate of senescence were in favor of a better postharvest conservation of tomato fruits as results of soil amendment with NSC.

**Keywords:** Bioeffectors, *solanum lycopersicum*, growth, development, ripening, postharvest conservation

## 1. Introduction

Tomato (*solanum lycopersicum*) is a horticultural plant originated from South America [1]. It is ranged 2nd after potato in worldwide consumption with an estimated world production of 129 million tons [2]. In Africa, Egypt is the first producer with 50% of the production [2]. Cameroon production is ranked 5th in Africa and is concentrated in the Western Highlands with more of the half of the total in country production [3]. According to Tueche *et al.* [4], the rural population is exposed to continuous poverty in Sub-Saharan Africa. The valorization of horticultural sector is a possible way to improve socio-economical household of the people living in rural areas. Tomato production may constitute a dynamic source of revenue in rural areas and help its habitants to ensure their alimentary security and nutritional balance [5].

In tropical regions, tomato production is confronted to many biotic and abiotic threats which lead to decreases in yield and fruit quality in postharvest periods [6, 7]. The yield drop is often due to poor fertilizers and pesticides

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management and poor quality of seeds used [8]. Preharvest factors such as field management practices, cultivar screening and improvement can have profound influences on plant vegetative stage and fruit quality [9]. These factors affect physiological and biochemical process which have direct or indirect effect on plants and their products [10]. Fontem [6] showed that the most used agricultural methods in Cameroonian Western Highlands are traditional practices which favourite pathogenic microorganisms related diseases and the depletion of soil fertilization, and as consequent lead to decreases from 20 to 80% in tomato yield. Many authors have focused their attention on the problem of yield depletion in Sub-Saharan Africa [5]. Traditionally, farmers use chemicals inputs in order to increase yield [8] although these chemicals have residual effects on consumer's health and environment [11].

Understanding the physiological functions of preharvest factors and their management is very important in order to achieve maximum yield, improve quality and extend shelf life of fruits [12]. Therefore, new agricultural practices focusing much more on ecological and consumer health impacts are pertinent alternatives to conventional plant cultivation methods. In this regard, bioeffectors (biological material or their extracts with ability to regulate growth and development of plants or also act like pesticides and fertilizers) are excellent potential candidates. The neem seed cake, a by-product of the extraction of neem seed oil is rich in mineral compounds [13, 14]. It is used to make organic manure, acts as a biofertilizer and helps to provide the necessary nutrients to the plants; it plays the role of pesticides, acts as a soil enhancer, and increases plant yields [15, 16, 17]. It is a soil conditioner that helps to improve soil quality, and therefore improve plant and fruit growth [18, 19]. Furthermore, it has a positive effect on the population of organic nitrogen users and actinomycetes, and significantly increases soil electrical conductivity [20]. Moreover, the use of N/P/K (20/10/10) at 200 kg $ha^{-1}$, neem seed cake at 4 t $ha^{-1}$ and their combinations favoured vegetative growth [21]. To the best of our knowledge, no study exists on the effects neem seed cake on tomato plant growth and development, the ripening and storability of resulting fruits in Western Highlands of Cameroon. The present study was thus undertaken to fill this gap.

## 2. Material and Methods

### 2.1 Presentation of the Experiment Site and Plant Material

The study was conducted at the locality of Bafoussam in the West Region of Cameroon, Mifi Division and Subdivision of Bafoussam 2 during the period of November 2019 to February 2020. Tomato seeds (*Solanum lycopersicum* L. var Rio de Grande) were purchased at a Technisem shop in Bafoussam. The seeds were sown on the $18^{th}$ November 2019 on 1 × 2 m beds. 30 days after sowing, seedlings were transplanted in 15 × 30 cm pots containing each 5 kg of soil and having six holes at their bottom and sides in order to eliminate excess of water. The pots were grouped in a complete randomize block design with four treatments (0 g, 4 g, 8 g and 12 g of neem seed cake per pot) and six repetitions. The fertilization began at the $2^{nd}$ week after transplantation of seedlings. The neem seed cake was administrated at three weeks intervals. Synthetic insecticide and fungicide were sprayed weekly to protect plant against pathogens. Plant was watered each day in the afternoon.

### 2.2 Determination of Plant Growth and Development, Fruit Ripening and Storability Parameters

The height of plants, number of leaves and diameter of plant were assessed at the $2^{nd}$, $4^{th}$ and $6^{th}$ weeks after seedling transplantation. The measurement of the height was done from the base to the terminal bud of the plant with a decameter. The plant diameter was determined using a Vernier caliper. The number of branches per plant was determined at the end of the culture. The date of $1^{st}$ flowering after plant transplantation, the number of flower buds, the number of flowers and the number of fruits were determined. The number of grapes per plant and the number of fruits per plant were determined at fruit red ripe stage. Lateral and longitudinal diameters of red ripe fruits were measured with a Vernier caliper.

The total soluble solids content (TSSC) was determined according the Navarre and Navarre method [22]. Two drops of tomato fruit juice free of bubbles and floating particles were deposited on the prism of refractometer (brand name: Aichose; model: SR0017-ATC; China) and the reading (in °Brix) was made in the presence of an incandescent lamp.

For the determination of the titratable acidity, 5 ml of tomato fruit juice were added to 20 ml distilled water and the mixture was homogenised using a magnetic stirrer. The pH of this mixture was then raised to 8.1 under continuous stirring using 0.1M sodium hydroxyl (NaOH). TA was calculated using the following formula elaborated by Gharezi *et al*. [23]:

$$\text{TA}(\%) = \frac{\text{Titre value} \times \text{Normality} \times \text{m.eq. wt. of acid}}{\text{Volume of sample}} \times 100$$

Where milli-equivalent weight of citric acid = 0.06404

The ripening index (RI) of fruits was estimated by the ratio of the total soluble solid content and titratable acidity (RI = TSSC / TA).

The content of pigments was determined according to the method described by Nagata and Yamashita method [24]. 4 g of fruit previously crushed in the presence of sand were introduced into a test tube containing 10 ml of acetone/hexane mixture (4/6, v/v). The tube was wrapped with aluminium paper impervious to light rays and left inside the ice for 10 minutes to obtain two separate phases. The optical densities (ODs) of the extracts (supernatant) were measured at wavelengths of 453 nm, 505 nm, 645 nm and 663 nm, using a spectrophotometer (brand: Biochrom Libra; model: S22 UV/Vis; Germany). The ODs obtained were used in the formula elaborated by Nagata and Yamashita [24] to evaluate the content of β-carotene and lycopene in tomato fruits.

The weight of fruits was measured on the $2^{nd}$, $5^{th}$, $8^{th}$ and $11^{th}$ day after harvest with an electronic balance (generic brand; model: SF-400; France). The physiological weight loss (PWL) was expressed as a percentage of the initial weight according to the formula of Gharezi *et al*. [23] below:

$$PWL (\%) = [(IW-WT) / (IW)] \times 100$$

Where PWL represents the physiological fruit weight loss, IW corresponds to the initial weight of the tomato fruits and WT to the weight of the tomato fruits at a definite time.

The firmness of fruits was measured using a penetrometer (brand name: SAUTER GmbH; model: GY-2; Germany) according to the method described by Mehinagic *et al*. [25]. Discs of peel of 2 $cm^2$ were removed from three places in the equatorial part of the fruit for this purpose. After setting the penetrometer dial to zero, the head of its cylindrical tip (diameter= 4 mm) was placed on the pulp of the peeled area of the fruit. Continuous downward pressure was applied manually so that the tip dipped into the fruit to the depth marked at the halfway point on the penetrometer tip. The tip was then removed and the value indicated on the penetrometer dial was noted. The firmness of the pulp was expressed in kilogram-force.

## 2.3 Statistical Analysis

The statistical analysis of data was done using R software version 3.6.2. The data obtained were submitted to an analysis of variances (ANOVA) in order to verify if differences exist between the means. The multiple comparison Tukey test was use at probability threshold of 5% to separate means in cases of differences.

## 3. Results

## 3.1 Tomato Plant Growth Parameters

The analysis of variance showed that on the $2^{nd}$, $4^{th}$ and $6^{th}$ weeks after transplantation (WAT) of seedlings, the tomato plant height was significantly influenced by the previous neem seed cake (NSC) input into the soil. Controls (T0 plants) and tomato plants grown on soil amended with NSC at 12g/pot (T3 plants) had respectively the smallest and biggest height during the sampling period. The number of leaves was not influenced by the NSC input on the $2^{nd}$ WAT. On the $4^{th}$ WAT, the number of leaves of T3 plants was higher (p= 0.030) than those of T0 plants and plants that received NSC at 4g/pot or 8g/pot (T1 or T2 plants). On the $6^{th}$ WAT, all tomato plants that received the NSC had a higher (p= 0.000) number of leaves than T0 plants. The highest number of leaves was recorded on the $6^{th}$ WAT in T2 or T3 plants. On the $2^{nd}$ WAT, diameters of T2 and T3 plants were higher (p= 0.006) than that of T0 plants. No difference could be observed on the same date between the diameter of T0 and T1 plants. On the $4^{th}$ WAT, all plants that received NSC had higher (p= 0.004) diameters than T0 plants. On the $6^{th}$ WAT, the diameter of T0 plants was smaller (p= 0.009) than that of T2 and T3 plants. The diameter of T0 plants was similar to that of T1 plants on the $6^{th}$ WAT. Concerning number of branches per plant, there were very high differences (p= 0.000) between means values, T0 and T2 plants having had respectively the smallest and the biggest number of branches (Table 1).

## 3.2 Tomato Plant Development Parameters

Table 2 shows variations of tomato plant development parameters after amendment of the soil with the neem seed cake (NSC). The number of grapes per plant was statistically significantly (p= 0.006) higher in plants that received NSC at 4g/pot (T1 plants) or 12g/pot (T3 plants) than control plants (T0 plants). High differences (p= 0.003) were observed between the number of flower buds in control plants and the number of flower buds in plants that received NSC at 8g/pot (T2 plants) and T3 plants, T2 and T3 plants having had higher number of flower buds than T0 and T1 plants. There were also significant (p= 0.022) differences in the time elapse between the seedling transplantation date and the date of the appearance of the first flower (TETAF) in T0, T1 and T2; T1 and T2 plants showed the shortest TETAF whereas T0 plants showed longest TETAF. T3 plants produced more (p= 0.022) flowers than control plants. There was no difference between the number of flowers produced by T0, T1 and T2 plants. Similar trends as that found in changes in the number of flowers produced per plant were observed in the variations of the number of fruits per plant and the fruit weight after soil amendment with NSC. Thus, the number of fruits per plant and the fruit weight were higher (p= 0.001) in T3 plant than T0 plants, and there was no difference between values of these parameters in T0, T1 and T2 plants. No difference could be observed between the lateral and longitudinal diameter of fruits produced by control plants and those produced by all plants that received the NSC.

**Table 1 - Changes in the growth parameters of tomato plants as related to the input of neem seed cake into the soil**

| | Treatments | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **T0** | **T1** | **T2** | **T3** | **Means** | **P-values** |
| PH 2 | 18.06±1.74a | 19.15±1.46a | 24.60±1.74b | 23.46±2.32b | 21.32±3.31 | 0.000 *** |
| PH 4 | 31.08±2.33a | 34.93±2.03a | 43.86±1.87b | 42.96±4.20b | 38.21±6.08 | 0.000 *** |
| PH 6 | 55.53±1.65a | 60.36±2.38b | 66.33±2.35c | 65.05±3.34c | 61.82±4.93 | 0.000 *** |
| NL 2 | 4.66±0.81a | 5.00±0.89a | 5.00±0.63a | 4.66±0.51a | 4.83±0.70 | 0.743 $^{ns}$ |
| NL 4 | 10.83±1.16a | 13.33±2.42ab | 12.16±1.32ab | 13.50±1.04b | 12.45±1.84 | 0.030 * |
| NL 6 | 28.00±2.09a | 33.50±2.88b | 35.83±1.94b | 35.83±2.85b | 33.29±4.00 | 0.000 *** |
| PD 2 | 4.36±0.52a | 5.03±0.68ab | 5.85±0.54b | 5.46±0.83b | 5.17±0.83 | 0.006 ** |
| PD 4 | 7.10±0.63a | 8.25±0.75b | 8.26±0.45b | 8.16±0.30b | 7.94±0.72 | 0.004 ** |
| PD 6 | 7.85±0.92a | 8.68±0.75ab | 9.18±0.42b | 9.11±0.43b | 8.70±0.64 | 0.009 ** |
| NB/P 6 | 7.16±0.98a | 9.66±1.50b | 9.83±0.75b | 10.00±0.89b | 9.16±1.55 | 0.000 *** |

Values followed by the same letters in the same row are not significantly different at 5% probability threshold according to the Tukey test. PH 2: plant height on the 2$^{nd}$ week after transplantation; NL 2: number of leaves per plant on the 2$^{nd}$ week after transplantation; PD 2: plant diameter on the 2$^{nd}$ week after transplantation; NB/P 6: number of branches per plant on the 6$^{th}$ week after transplantation. T0: control plants; T1: plants that received the neem seed cake (NSC) at 4g/pot; T2: plants that received the NSC at 8g/pot; T3: plants that received the NSC at 12g/pot.

**Table 2 - Changes in the development parameters of tomato plants as related to the input of neem seed cake into the soil**

| | Treatments | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **T0** | **T1** | **T2** | **T3** | **Means** | **P-values** |
| NG/P | 10.16±1.16a | 12.83±1.72b | 11.16±0.98ab | 12.16±0.75b | 11.58±1.52 | 0.006 ** |
| NFB/P | 56.00±4.89a | 60.33±5.46ab | 65.83±5.07b | 65.50±2.34b | 61.91±5.97 | 0.003 ** |
| TETAF | 25.00±1.41b | 21.16±2.31a | 21.50±1.97a | 23.16±2.71ab | 22.70±2.54 | 0.022 * |
| NFl/P | 46.50±4.96a | 53.33±5.64ab | 53.33±5.46ab | 56.66±4.92b | 52.45±6.19 | 0.022 * |
| NFr/P | 35.00±2.82a | 42.33±4.13b | 40.00±2.00ab | 45.00±5.05b | 40.58±5.09 | 0.001 ** |
| FW (g) | 57.78±8.10a | 62.77±8.29a | 63.13±8.37ab | 69.93±7.37b | 63,39±8,83 | 0.001 ** |
| LoD (cm) | 51.19±5.11ab | 55.17±4.25b | 50.93±5.09a | 54.38±6.27ab | 43.58±4.38 | 0.0156 * |
| LaD (cm) | 42.43±4.42a | 44.78±4.29a | 42.55±3.71a | 44.66±5.37a | 52.90±5.30 | 0.190 $^{ns}$ |

Values followed by the same letters in the same row are not significantly different at 5% probability threshold according to the Tukey test. TETAF: the time elapsed between the seedling transplanting date and the date of the appearance of the first flower; NG/P: number of grapes per plant; NFB/P: number of flower buds per plant; NFl/P: number of flowers per plant; NFr/P: number of fruits per plant; LoD: longitudinal fruit diameter; LaD: lateral fruit diameter; FW: fruit weight; T0: control plants; T1: plants that received the neem seed cake (NSC) at 4g/pot; T2: plants that received the NSC at 8g/pot; T3: plants that received the NSC at 12g/pot.

## 3.3 Tomato Fruit Quality and Storability Parameters

There was an overall treatment-independent increase in the physiological weight loss (PWL) in tomato fruits with increasing conservation duration. In comparison to controls, previous soil amendment with the neem seed cake (NSC) at 12g/pot led to statistically significant reductions of the PWL in tomato fruits from the 5$^{th}$ day after harvesting (DAH) onwards. On the 11th DAH, fruits produced by tomato plants grown in the soil amended with the NSC at 4g/pot, 8g/pot and 12g/pot showed physiological weight losses that were lesser (p= 0.002) than those of fruits produced by control plants. No difference existed between the shelf life of control fruits and that of fruits produced by plants that received the NSC. The senescence rate assessed on the 11th DAH of fruits produced by plants that received NSC at 12g/pot (T3 plants) was lower (p= 0.041) than that of fruits produced by control plants (T0 plants). At the same period, no difference could be observed between the rate of senescence of fruits produced by T0 plants and that of fruits produced by plants that received NSC at 4g/pot (T1 plants) or 8g/pot (T2 plants). Concerning quality parameters, the there was no difference in contents of lycopene, β-carotene and total soluble solids, and the firmness of fruits. However, soil amendment with NSC led to increases in the titratable acidity, these increases having been highly statistically valid (p= 0.000) in fruits produced by T1 and T2 plants as compared to fruits produced by T0 plants. Furthermore, the ripening index of fruits produced by T0 plants was higher (p=0.005) than that of fruits produced by T1, T2 and T3 plants (Table 3).

**Table 3: Changes in the quality and storability parameters of tomato fruits as related to the input of neem seed cake into the soil**

| Parameters | Treatments | | | | Means | P-values |
|---|---|---|---|---|---|---|
| | **T0** | **T1** | **T2** | **T3** | | |
| PWL 2 (%) | 1.95±0.72a | 1.64±0.44a | 1.81±0.31a | 1.44±0.12a | 1.72±0.49 | 0.454 ns |
| PWL 5 (%) | 5.10±1.27b | 4.25±1.29ab | 5.02±1.41b | 3.39±1.14a | 4.42±1.43 | 0.001 ** |
| PWL 8 (%) | 8.16±1.63b | 6.16±1.91a | 6.75±1.31ab | 6.23±1.49a | 6.79±1.73 | 0.009 ** |
| PWL 11 (%) | 12.96±2.78b | 9.30±2.37a | 10.43±1.76a | 9.38±1.39a | 10.36±2.42 | 0.002 ** |
| SL (days) | 11.57±1.65a | 12.20±1.08a | 12.26±1.33a | 12.33±1.23a | 12.10±1.33 | 0.405 ns |
| SR 11 (%) | 67.85±42.56b | 34.37±35.30ab | 22.22±30.88ab | 10.66±17.38a | 34.78±37.95 | 0.041* |
| FNESS (kg/f) | 3.96±0.05a | 4.00±0.00a | 3.88±0.19a | 3.98±0.02a | 3.96±0.09 | 0.563 ns |
| Lyco (mg/100 g) | 0.23±0.12a | 0.28±0.03a | 0.21±0.06a | 0.35±0.048a | 0.26±0.08 | 0.136 ns |
| β-Car (mg/100g) | 0.08±0.01a | 0.13±0.06a | 0.11±0.01a | 0.17±0.04a | 0.12±0.04 | 0.112 ns |
| TA (%) | 0.24±0.02a | 0.42±0.09bc | 0.53±0.01c | 0.36±0.01ab | 0.37±0.12 | 0.000 *** |
| TSSC (°Brix) | 5.66±0.57a | 5.00±1.00a | 4.53±0.50a | 5.40±1.04a | 5.15±0.82 | 0.404 ns |
| RI | 0.09±0.01b | 0.06±0.02a | 0.05±0.01a | 0.04±0.01a | 0.06±0.02 | 0.005 ** |

Values followed by the same letters in the same row are not significantly different at 5% probability threshold according to the Tukey test. PWL5: physiological weight loss of fruits on the 5th day after harvesting; SL; shelf life; TSSC: total soluble solid content; TA: titratable acidity; RI : ripening index; Lyco: lycopene; β-Car: β-carotene; SR 11: senescence rate of fruits on the 11th day after harvesting; FNESS: firmness; T0: control plants; T1: plants that received the neem seed cake (NSC) at 4g/pot; T2: plants that received the NSC at 8g/pot; T3: plants that received the NSC at 12g/pot.

## 4. Discussions and Conclusion

### 4.1 Tomato Plant Growth Parameters

The data obtained showed that addition of the neem seed cake (NSC) to the soil led to significant improvements of agro-morphological parameters of tomato such as plant height, stem diameter, number of leaves and number of branches. These results suggested that the NSC acted like fertilizer in the soil and contributed to the enhancement of tomato plant growth parameters. Previous results on the improvement of plant growth by the NSC have been reported on *Sesanum indica* [16], *Oryza sativa* [26], *Solanum tuberosum* L. [27] and *Abelmoschus esculentus* (L.) Moench [28]. Furthermore, the use of green mature consisting of the herbaceous legume *Lablab purpureus* led to a significant improvement of the growth of two varieties of *Solanum esculentum* Mill. [29]. Thus, NSC and *Lablab purpureus* maintained soil fertility by forming an organic amendment which supplies plants with nutrients and thus leads to an increase in the vegetative growth [16, 26, 27, 28, 29]. Moreover, it has been reported by Agbenin *et al*. [30] that NSC has the potential to provide to the soil an important quantity of ammonium and nitrate which are the two forms of nitrogen assimilated by plant root while it is well established that high doses of nitrogen contribute to an increase in cell elongation and favourite cell division [31]. The NSC may also play double roles in the soil; it leads to an increase in the number of benefic microorganisms and to an improvement of soil quality traits like electrical conductivity and mineral content [20].

## 4.2 Development Parameters of Plant

Statistically significant differences were noticed between control plant development parameters and the same parameters measured in plants grown in a soil enriched with the NSC. This is how in comparison to controls, the time elapsed between the seedling transplanting date and the date of the appearance of the first flower was shortened following soil amendment with the NSC. Such an early flowering in tomato plants as a result of soil amendment with *Spirulina platensis* and *Jatropha curcas* has been reported by Aghofack-Nguemezi *et al*. [32], although in other cases an input of organic fertilizers (*Crotalaria retusa* and *Acacia albida*) into the soil did not lead to the shortening of the time elapsed between the seedling transplanting date and the date of the appearance of the first flower in tomato plants [33]. It is well established that the NSC is a rich source of minerals such as nitrogen, phosphorus, potassium, calcium, etc. [18, 34, 35]. The NSC may also contribute to the amelioration of soil properties such as potential exchange capacity, pH and exchangeable acidity [36]. All these known potential soil modifying properties of the NSC could contribute to the rapid growth of plant and an earliness of the flowering process. As consequence of this reduction of floral maturation age, subsequent development parameters such as the number of flower buds per plant, the number of flowers per plant, the number of grapes per plant and the number of fruits per plant statistically significantly increased after the application of the NSC on the soil.

## 4.3 Fruit Quality and Storability

Most of the quality and storability parameters of fruits were not influenced by the input of NSC into the soil. However, there were statistically significant reductions of the physiological weight loss (PWL) and senescence rate, and an increase in the titratable acidity of tomato fruits as results of the soil amendment with neem seed cake. The specific fruit transpiration rate depends on the species, the conductance properties of the fruit skin and the driving force which is the difference in water vapor pressure between the airspaces inside the fruit and the air immediately outside it [37]. It is well established that for most fruits accelerated water loss reduce their quality and duration of conservation [38, 39], so that in order to reach maximum post-harvest life span the water content in fruits should be maintained at optimal level. Thus, many research works reported the positive effects of methods leading to the lowering of the PWL on the prolongation of the fruit post-harvest conservation duration [40, 41, 42, 43]. Titratable acidity is one of the most important quality parameter of fruits and an essential contributor to the flavor [44, 45]. Anthon *et al*. [46] reported that when ripe tomatoes were allowed to remain on plants for up to 4 weeks there was an increase in fruit pH of between 0.01 and 0.02 units per day for the four cultivars examined. This increase in pH was paralleled by a decrease in titratable acidity (TA), due to a loss of citric acidity, what could adversely affect the tomato fruit quality. The significant increase of the TA in tomatoes as a result of the soil application of NSC in the present study indicated therefore that NSC input led to an improvement of the quality of fruits.

## 4. Conclusion

Soil amendment with the neem seed cake (NSC) at various doses contributed to the enhancement of tomato plant growth and development parameters and positively influenced some quality and storability parameters of fruits produced. The dose of NSC of 12g/plant was the most effective in improving the parameters measured.

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