



## Effect of Different Types of Soil on the Growth & Productivity of Tomato *Solanum lycopersicum* var. *Rio Grande* in Libya

Najia Shwerif<sup>1\*</sup>, Abdunnapi Elghammudi<sup>1</sup>, Samaher Abosnena<sup>1</sup>  
and Amna Alfaid<sup>1</sup>

<sup>1</sup>Department of Botany, Faculty of Science, Gharyan University, Libya.

### Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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### ABSTRACT

The growth performance of plants varies in different environments and is strongly influenced by various biotic and abiotic factors. This, in turn affects the composition of the active compounds which are the product of metabolism (such as photosynthesis, respiration, etc.). Soil quality is considered to be important factor that negatively affect plant growth and productivity. Tomatoes are widely produced and consumed due to their high nutritional value and its important compounds have a role in the prevention of many diseases. Therefore, the aim of this study was to determine the effects of three different soil types (clay, sand and compost) on growth and yield parameters of tomato *Solanum lycopersicum* var. *Rio Grande*. The experiment was done on the Faculty of Science in Gharyan University (April 2017). The tomatoes were grown in pots; twelve replications were used for each group of soils. Growth parameters such as number of seedling, plant height, number of leaves and number of fruits were recorded. The results indicated that soil quality had a highly significant effect ( $P < 0.001$ ) on growth parameters. Compost was the optimal soil types for growth performance and production of tomatoes, while the growth performance was reduced in clay and sand soil. By contrast, tomatoes that grew in clay soil showed the least growth performance. On the

\*Corresponding author: E-mail: [alshwerif@yahoo.com](mailto:alshwerif@yahoo.com);

other hand, tomato plants cultivated in clay and sand soil failed in production of flowers and fruits, unlike tomatoes grown in compost. Overall, soil quality and properties have affected tomato growth performance and productivity.

**Keywords:** Tomato; mineral nutrients; soil quality; compost and plant growth.

## 1. INTRODUCTION

The growth, yield and quality of tomato fruits can be affected by genetic potential and environmental factors such as light, temperature and availability of nutrients [1]. Since a long time, scientists have studied plant nutrition to understand how the mechanisms of accumulation, transport and functions of chemical elements in plants. However, much information has been investigated on the growth and composition of plants and their response to the elements contained in the soil. The plant benefits from several essential soil elements known as mineral nutrients required for enhancing growth and productivity [2]. In order for the element to be necessary, it must be required to complete the plant life cycle, and these elements cannot be substituted with any other nutrients [3]. The soils of the zone are low in organic matter, which are poorly buffered and are made up of low activity clay with kaolinite as dominant clay fraction. Therefore, soils of this type are characterized by low cations and water retention capacities [4,5,6,7]. It is possible to make broad generalizations regarding nutrient requirements of crops. This is because quite often soil texture is one of the factors that influence crop growth and yield, tissue nutrient concentrations and crop response to treatments [7]. Despite this fact, few studies have been evaluated for vegetative characteristics of tomatoes grown in different types of soil. The soils in Libya are slightly or moderately weathered soils of arid areas. There are two locations that are known as the most arable lands in Libya. One of them is Al Jabal Al Akhdar in the northeast region while the other one is Al Jifarah plain in the northwest region. About Ninety five percent of the country is almost desert with 1.2% being under cultivated. The features of the soils are typically shallow, sandy texture, low in organic matter content and water holding capacity [8].

## 2. MATERIALS AND METHODS

### 2.1 Materials

The following research facilities were used including Petri dishes, incubation (Memmert 100-

800), 36 plastic pots (300 liter), tomato seeds *Solanum lycopersicum* var. Rio Grande-germination 85%- purity 99), Ruler, camera (Sony). The three main types of soils (different composition and different locations) were as following: (A) clay soil: A sample was taken from Gharyan city, where no fertilizer was used. The sample was taken about 30-60 cm from soil depth (Table 1). (B) Sandy soil: A random sample was collected from Ben Ghashir region, characterized by high field capacity and sampled about 60 cm soil depth (Table 2). (C) Compost (BAS VAN BUUREN) was purchased from commercial markets, and its properties presented in Table 3.

**Table 1. Morphological, physical and chemical properties of clay soils [9] and [10]**

Parameter	Properties / Value
Texture	Loamy Sandy
Dissolved Salts (%)	0.6
Calcium Carbonate (%)	1.0
Electrical Conductivity (Ec) Ds/ M	0.4
Exchangeable Sodium (%)	1.4
Organic Matter (%)	0.7
Ph	8.2
Gypsum (%)	0.0
Total Nitrogen (%)	0.01
Phosphor (ppm)	0.4
Potassium (ppm)	80

**Table 2. Morphological, physical, mechanical and chemical properties of sandy soils, [10] and [11]**

Parameter	Properties / Value
Texture	Sandy
Sand %	95.8
Silt %	3.50
Clay %	0.07
Ph	7.58
Electrical Conductivity (EC) %	0.89
Calcium Carbonate %	0.13
Exchanged Sodium %	0.6
Organic Matter %	0.03
Total Nitrogen %	0.003
Phosphor ppm	2.1
Potassium ppm	116

**Table 3. Physical and chemical properties of compost**

Parameters	Value
Organic Matter %	20
PH	6.5
CE $\mu$ S/CM	350
SALT CONTENT G/L	1.5
NITROGEN MG/L	300 - 300
PHOSPHORUS MG/L	150 - 300
POTASSIUM MG/L	400 - 400

## 2.2 Methods

### 2.2.1 Seedgermination test

A random sample of pure seeds was selected and ten seeds were distributed in Petri dishes containing wet filtration papers. The number of dishes (6) were placed in incubation at 24°C and the other three dishes were placed at room temperature (20°C). Daily germination rate was monitored for both groups for one week and the number of developing seeds was recorded. The germination ratio was calculated as following (number of seeds / total number of seeds)  $\times$ 100%.Seed germination rate in incubation was faster than seed germination at room temperature (9:7) respectively. Therefore, seedlings growing in incubation were selected for experiment, and then seedlings were transplanted to pots.

### 2.2.2 Seedlings transplantation stage

A small hole 3 cm deep was placed in the middle of each pot, where each seedling was placed (which was grown in the incubation for 5 days). All the plants were placed in same location (university field) and irrigated with equal amounts of distilled water.

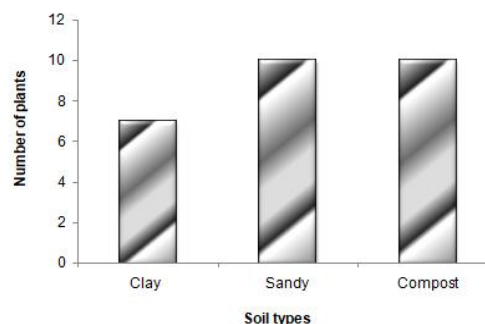
### 2.2.3 Data analysis

A factorial analysis with comprising three soil treatments was applied to assess the statistical significance differences among treatments in a completely randomised design (CRD). All variables were analysed by a mono-variance and Fischer test to compare the means of each of the three soil types. Differences among means were established using a least significant differences test ( $P < 0.05$ ) using Minitab 17.

## 3. RESULTS

### 3.1 Growth Rate of Seedling

In sandy soil and compost, the plants were grown better than the plants grown in clay soil, mainly because of the nutrient content in the sandy soil and compost (Fig. 1).



**Fig. 1. Effect of different soil types on plant growth of *Solanum Lycopersicum* var. *Rio Grande***

### 3.2 Number of Leaves

There was a considerable effect of soil types on growth of tomatoes and the rate of leaf production. Clay and sandy soils resulted in production of few numbers of leaves during the entire experimental time (weeks). In contrast, compost encouraged rapid growth and leaf production. The results in Fig. 2 showed that compost had the best growth performance and improved number of leaves, followed by sandy soil. By contrast, clay soil was the least in terms of growth and least number of leaves produced.

### 3.3 Plant Height

There were consistent and large effects of soil types on plant height ( $P < 0.001$ ), (Fig. 3).

**Table 4. Comparison of the effect of different types of soils on height of *Solanum Lycopersicum* var. *Rio Grande***

Comparison	P-Value
Clay Soil $\times$ Sandy Soil	0.652
Sandy Soil $\times$ Compost	0.000
Clay Soil $\times$ Compost	0.000
Clay $\times$ Sandy $\times$ Compost	0.000

### 3.4 Number of Flowers and Fresh Weight of Tomato

The experimental result indicated that the beginning of the flowering period was in the fifth week (after 35 days), which is the natural period of the flowering period for most types of tomatoes. Also, an increase in growth resulted in

increased the production of flowers until it reached 21 flowers in the third month. In contrast, the plants of both sandy and clay soil failed to reach the flowering stage due to slow growth compared with growing tomatoes in compost. Table 5 further showed a significant difference ( $P < 0.002$ ) between weights of fruits ranging (from 3-32 g).

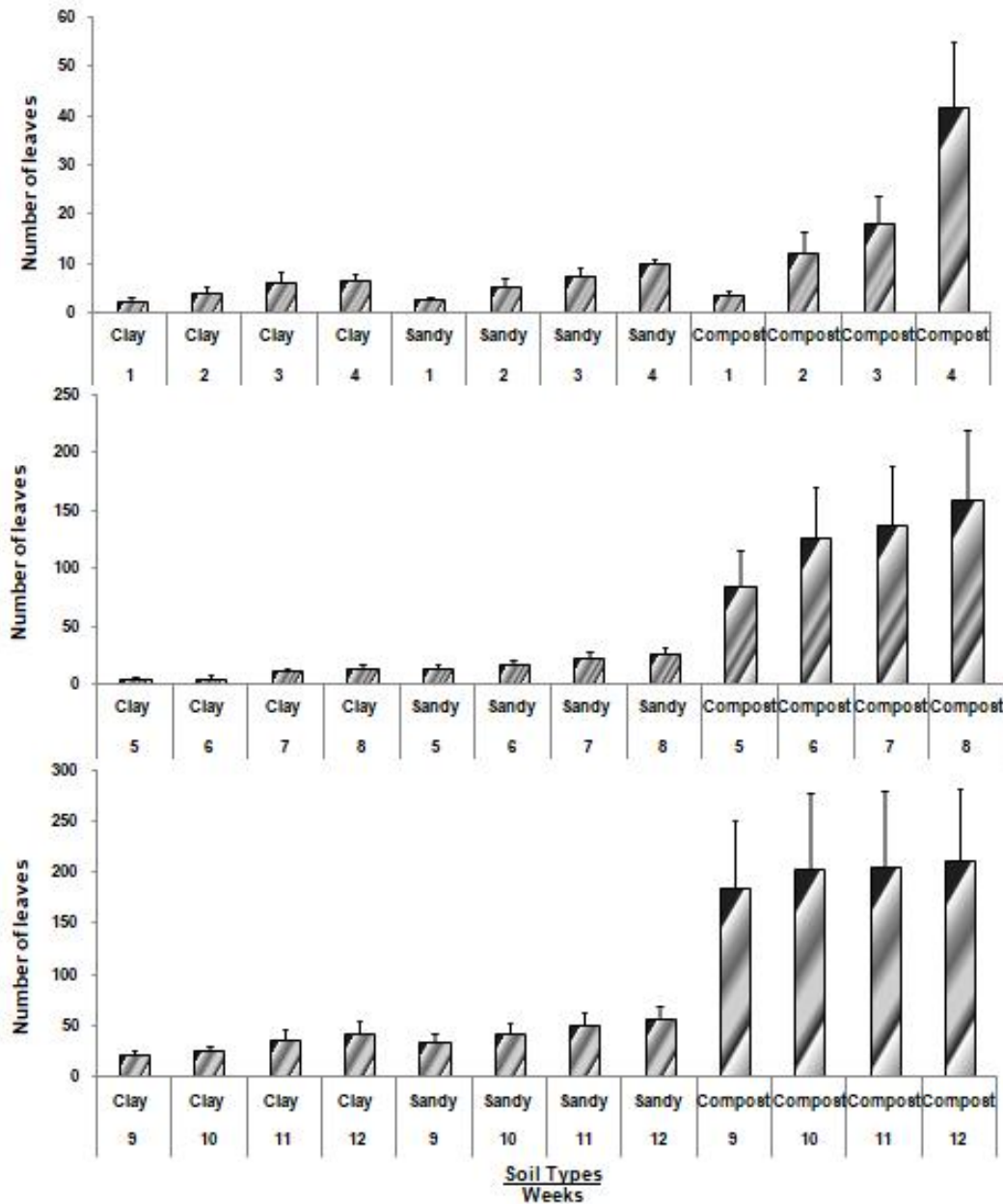


Fig. 2. Effect of different soil types on leaf production rate (per week) of *Solanum Lycopersicum var. Rio Grande*

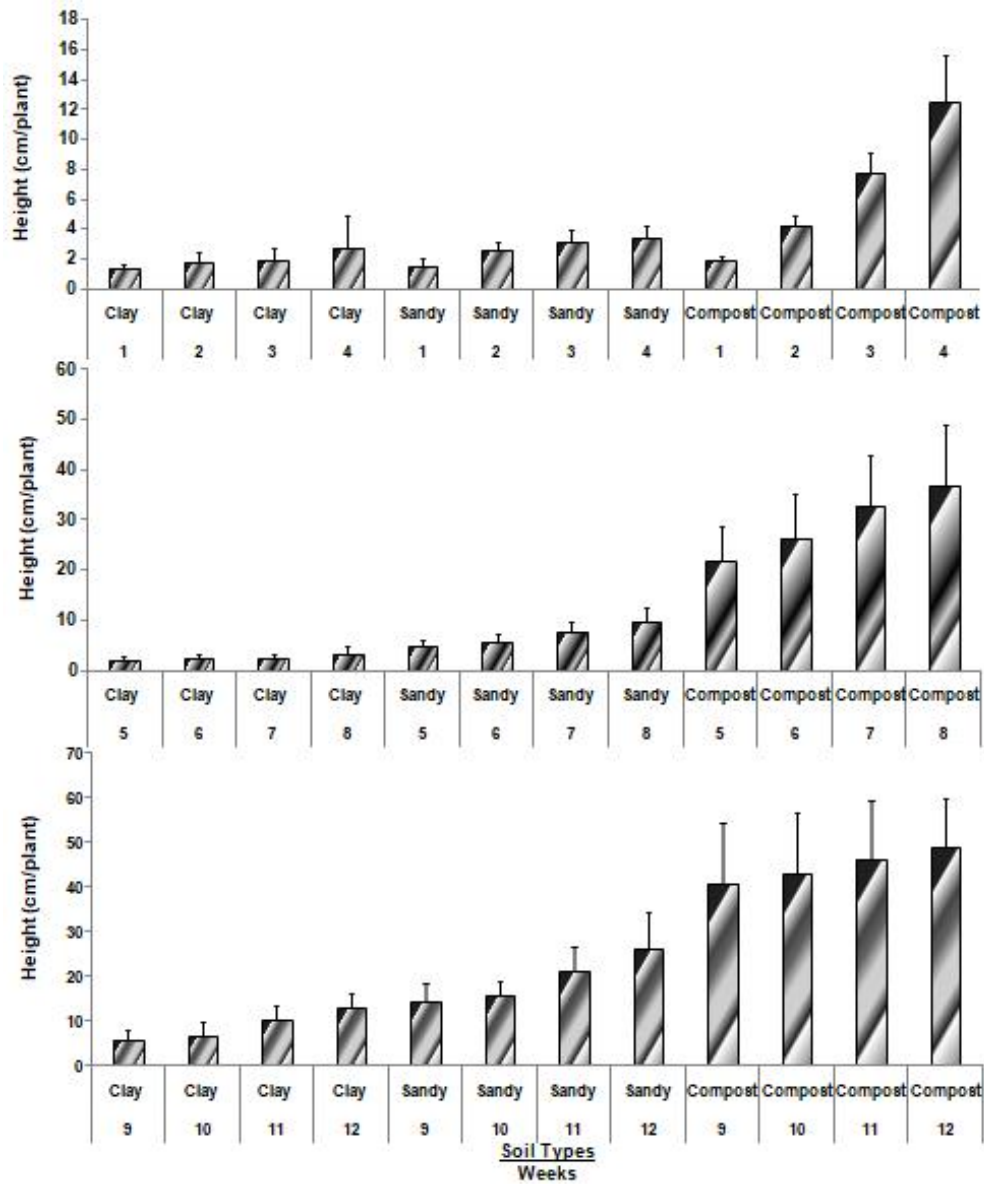


Fig. 3. Effect of different soil types on height of *Solanum Lycopersicum* var. *Rio Grande*

Table5. Analysis of variance for the number of flowers and fresh weight of *Solanum Lycopersicum* var. *Rio Grande* grown in compost

Number of flowers/ week	Fresh weight (g/fruit)
6 ± 2.11 c	2.97 ± 0.037 c
6.4 ± 2.19 c	8.76 ± 4.56 c
9.2 ± 1.64 c	4.94 ± 3.49 c
13.3 ± 4.44 b	16.07 ± 8.59 b
16.5 ± 5.02 b	11.38 ± 4.33 b
18.8 ± 4.64 b	32.92 ± 23.27 a
20.3 ± 5.14 a	5.86 ± 1.41 c
20.8 ± 5.77 a	4.41 ± 1.52 c

The values are Mean ± standard deviation (SD) of means followed by different letters, which indicate significant difference between fresh weights

#### 4. DISCUSSION

Vegetative characteristics of tomato *Solanum Lycopersicum* var. *Rio Grande* varied by different soil types. Tomato plants grown in compost were faster than plants grown on clay and sandy soils. On the contrary, tomato plants grown in clay soil were slower to grow during growth stages (height and number of leaves). Tomato plants grown in sandy soil were better in growth and the number of plants than the tomatoes grown in clay soil. The experiment lasted about 20 weeks. The tomato plants that grew in the compost were the leading in the growth in terms of height, number of leaves, flowers and fruits compared to the plants grown in the clay and sandy soil, which stopped growing after 12 weeks and did not attain to the stage of flowering and fruiting. When comparing the sandy soil with the clay soil in terms of height and the number of leaves, the sandy soil was better than the clay soil. The reason behind the slow growth of clay soil from the rest of the soils is that they are made up of very small particles, so it is called heavy soil, because they are difficult to hoeing [1] or they may be very fertile sometimes but they do not have good drainage. Therefore, if the soil is wet due to irrigation, it will block and prevent soil aeration. Our flowering period (36-39 days) is in agreement with the results obtained by [12] for the same tomato genotype. Additionally, our results of the number of leaves that are obtained due to the availability of nutrients, especially nitrogen, which enhances vegetative growth, agreed with the results that are obtained by [13], who concluded that applications of organic and inorganic fertilizers can increase vegetative growth and cause a greater increase in tomato leaves. Compost is the most suitable growth media for the growth of the majority of plants because it contains the most important micronutrient (nitrogen, phosphorus, and potassium) [14]. It also plays a key role in maintaining the growth of microorganisms; as well as it reduces the needs for pesticides, reduces the risk of plant diseases, and can be added at any time of the year, [15].

Irrigated agriculture (in sandy soils) requires the selection of a highly efficient system to reduce irrigation water loss by deep seepage and loss of elements by washing with the application of an appropriate fertilization program and appropriate measures to reduce wind erosion [10]. In the case of clay soil, with the availability of irrigation water, taking care of organic and chemical fertilization, which is necessary for this type of

soil, production will increase dramatically to compensate for the decrease in the content of organic matter that characterizes this soil [9].

#### 5. CONCLUSION

Tomato varieties differ in environmental requirements such as soil types, temperature and irrigation quantity and are significantly affected by these factors. Tomato *Solanum Lycopersicum* var. *Rio Grande* is one of the varieties that cannot grow in different soil types; it requires a suitable type and composition of soil especially in Libya, and it is considered as an undesirable species in the cultivation (as indicated by the results). The opinions of some farmers whose views were taken about this variety, on the contrary, this variety is very desirable and it is an extensive production in many European countries, such as Italy. Improving poor soil so as to improve nutrients and thus increase the productivity of tomatoes in Libya are important strategies that should be taken into consideration as tomatoes are important vegetables for consumption in Libya.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Akamine H, Hossain A, Ishimine Y, Yogi K, Hokama K, Iraha Y, Aniya Y. Effects of application of N, P and K alone or in combination on growth, yield and curcumin content of turmeric (*Curcuma longa* L.). *Plant Production Science*. 2007;10:151-154.
2. Krumbein A, Schwarz D, Kläring H. Effects of environmental factors on carotenoid content in tomato (*Lycopersicon esculentum* (L.) Mill.) grown in a greenhouse. *Journal of Applied Botany and Food Quality*. 2006;80:160–164.
3. El-Ramady H, Alshaal T, Amer M, Domokos-Szabolcsy M, Elhawat E, Prokisch N, J, Fari M. Soil Quality and Plant Nutrition. 2014;14:345-447.

4. Ojanuga A. Clay mineralogy of Soils in the Nigerian tropical savanna regions. Soil Science Society of America Journal. 1979; 43:1237-1242.
5. Enwezor O, Udo E, Ayotade K, Adepetu J, Chude V. A review of soil and fertilizer use in Nigeria. In FPDD. Literature review on soil fertility investigations in Nigeria. Federal Ministry of Agriculture and Natural Resources, Lagos. 1990;5:241-281.
6. Odunze E. Soil properties and management strategies for some sub-humid of savanna zone Alfisols in Kaduna State, Nigeria. Samaru journal of agriculture research. 2006;22:3-14.
7. Oyinlola E, Jinadu S. Growth, yield and Nutrient Concentrations of tomato as Affected by Soil Textures and Nitrogen. Asian Journal of Agricultural Research. 2012;6(1):39-45.
8. Hamdi A, Zurqani, Elena A, Mikhailova, Christopher J, Post, Mark A, Schlautman and Azzeddin R. Elhawej. A review of Libyan soil databases for use within an ecosystem services framework. Land. 2019;(8):82.
9. Solkhozprom Export. Soil Ecological Expedition, USSR. Soil studies in the Western Zone. Secret of Agr. Reclamation and Land Development. Tripoli, Libya; 1980.
10. Ben-Mahmoud KB. Libyan Soils, 1<sup>st</sup> ed. National Research Scientific Organization: Tripoli; 1995.
11. Abu Fares A. The types of soil in Bin Ghashir area, the General Authority for Soil, Water and sewerage, Tripoli, Libya. (In press); 2008.
12. Ali I, Khattak A, Ali M, Ullah K. Performance of different tomato cultivars under organic and inorganic regimes. Pakistan Journal of Agricultural Research. 2015;28(3):245-254.
13. Brown JE. Comparison of broiler litter and commercial fertilizer on production of tomato. J. Vegetable Crop Prod. 1995;1(1): 53-62.
14. Hossain A, Yaamanishi M, Yara T, Chibana S, Akamine H, Tamaki M. Growth characteristics, yield and mineral content of red flower ragleaf (*Crassocephalum crepidioides* (Benth.) S. Moore) at different growth stage, and in dark-red soil, red soil and gray soil in Okinawa. Science Bulletin of the Faculty of Agriculture. 2011;(58):1-11.
15. Al-Fayyad A, Abdullah M. Manufacture of organic fertilizer (Compost) from organic waste : Iraq; 2006.

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