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Original article

Impact of Salinity on the Growth of Tomato Plants (*Solanum lycopersicum*) Cultivated under Laboratory Conditions

Faraj Atiyah*, **Ebtihaj Saleh**, **Munyah Hammad**

Department of Botany, Science Faculty, Omar Al-Mukhtar University, El-Beida, Libya
***Corresponding Email.** faraj.atiyah@omu.edu.ly*

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Salinity, Tomato, *Solanum Lycopersicum*, Laboratory.

ABSTRACT

Globally, soil salinity is becoming a bigger issue that jeopardizes agricultural productivity. This study was conducted to address this problem by examining the " impact of Salinity on the Growth of Tomato Plants (*Solanum lycopersicum*) Grown in Laboratory Conditions." In the summer of 2022, the study was conducted in the Faculty of Science laboratory at Omar Al-Mukhtar University in Libya. Five different concentrations of sodium chloride were utilized as treatments in the study, which employed a completely randomized design: zero mM (Control), fifty mM, one hundred mM, one hundred and fifty mM, and two hundred mM. Examining different growth parameters, including plant height, leaf count, leaf size, and fruit production per plant, was the aim. Four tests were conducted on each treatment. Examining different growth parameters, including plant height, leaf count, leaf size, and fruit production per plant, was the aim. The results demonstrated that all of the growth variables assessed were significantly harmed by increased salt levels. For instance, plant height dropped by roughly 29.6% at the maximum salt concentration (200 mM). Similarly, other measures like the number of leaves for each plant, leaf area, and fruits per plant also showed a discernible decline, as did other variables like the number of leaves on each plant, the size of the leaves, and the number of fruits they produced.

Introduction

Global tomato output in 2022 was around 186,107,972 tonnes, with China producing almost 37% of the total [1]. You can eat tomatoes raw, cooked, or processed. Through canning, they are also transformed into tomato-based goods such as juice, pulp, paste, ketchup, and others [2]. Tomatoes are grown in many countries because they can adapt to different types of soil and weather. They are also known for being healthy, as they are full of antioxidants. There are two main types of tomatoes that are grown: one type is eaten fresh, like in salads, and is usually grown in controlled environments; the other type is used for making products like canned tomatoes and is usually grown in open fields [3]. These fruits are rich in natural chemicals and nutrients that are beneficial to your skin, health, and weight loss. Additionally, they might aid in the prevention or improvement of chronic health issues [4].

Carotenoids, including beta-carotene and lycopene, antioxidant vitamins C and E, and advantageous plant substances, including kaempferol, quercetin, lutein, and caffeic acid, are among the many nutrients found in tomatoes [5]. According to research by [6], rainwater can also increase the salt content of soil, with up to 650 mg/kg-1 of salt (NaCl) found in it. Plants are harmed by high salt levels and must respond [7]. It is stated that there are two phases to plant responses to salt: 1) The first few hours or days following exposure are when the ion-independent response occurs. Plants slow down their overall growth during this period, close their stomata (small holes on leaves), and stop cells from developing, particularly in the shoots. 2) Ion-dependent response: This occurs over days or weeks. It involves slower metabolism, early aging of the plant, and eventually, cell death [7].

Plants have ways to deal with salt stress through different processes that can be grouped into three main types: handling water loss, keeping harmful salt out, and protecting cells from salt damage [8]. When there's too much salt, plants can still grow by managing water loss, keeping their leaves open for air exchange (handling water loss), stopping too much salt from building up in their leaves and shoots (keeping harmful salt out), and moving salt away from important parts of the cell into storage areas to shield the plant's cells from the damaging effects of salinity [9], concluded that salt stress damages seed sprouting, plant health, and the final harvest, which lowers crop growth and production. Too much salt disrupts plant functions, harms processes such as photosynthesis, breathing, starch breakdown, and nitrogen use, and lowers crop yields [10]. When salt builds in plant tissues beyond what they can handle, it causes harmful changes in their structure, function, chemical processes, and productivity. These are: (1) a decrease in water availability in the root area, leading to water shortage, (2) detrimental effects on plants of ions such as Na^+, and (3) A lack of nutrients produced by reduced mobility or absorption to the shoots [11]. Nonetheless, several studies indicate that tomato plants cultivated in saline environments have greater concentrations of organic acids. A straightforward method to improve tomato quality is to add salt to the nutrition solution [12]. Because of their brief life cycle and well-understood genetic composition, tomatoes are an excellent choice for this type of research [13]. Their nutritional advantages and economic worth further emphasize the significance of

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this study. This study aimed to determine the way various soil levels of salt affect tomato plant growth. We'll look at the plant's size, the amount and shape of its leaves, the quantity of fruits, and the mass of each fruit. Selecting the best farming practices to satisfy the market's need for tomatoes requires an understanding of how salt affects tomato plants.

Methods

Experimental Design

In the summer of 2022, an experiment was conducted in the Faculty of Science lab at Omar Al-Mukhtar University in Libya. Five distinct treatments, each with four repetitions, were utilized in the completely randomized design (CRD) experiment. The salt (NaCl) concentrations used in the treatments ranged from zero mM (Control), fifty mM, one hundred mM, one hundred and fifty mM, and two hundred mM.

Culture and plant substance

In trays containing peat moss, tomato seeds *(Solanum lycopersicum*, AL-jabal Alakhdar variety) were sown. The same-sized seedlings were transferred to pots (25 cm wide by 40 cm tall) with 8 kg of soil after 21 days.

Soil Preparation

The test farm at a few of the AL-Jabal Alakhdar farm areas provided the soil. Before being utilized, it was cleaned and made safe. The pH level, electrical conductivity, amount of organic biomass, and nutrients were measured.

Table 1. Physicochemical properties of the soil used in the experiment.

The Soil Component	Values
pH	6.5
EC (dS/m)	0.8
Organic Matter (%)	2.5
Nitrogen (mg/kg)	150
Phosphorus (mg/kg)	30
Potassium (mg/kg) 1	100

Treatment of Salt

Salt Sodium chloride saltwater solutions were made in four levels: fifty mM, one hundred mM, one hundred and fifty mM, and two hundred mM. To accomplish the proper salinity levels, these saltwater mixes were utilized. To the pots. Pure water was used in place of salt in pots [14].

Fertilizing and watering

We used a drip irrigation system to make sure all plants got the same amount of water. Each pot was watered equally. We also added a balanced AOF fertilizer to the soil, using 50 milligrams for every kilogram of soil.

AOF = Al-Marae organic fertilizer

Data Collection

We took measurements of the plants' growth at various points in time. Among these metrics were: Plant height (cm), number of leaves per plant, leaf area (cm^2), number of fruits per plant, and weight of individual fruits (g).

Statistical Analysis

Data were analyzed using analysis of variance (ANOVA), and differences were considered statistically significant at $P < 0.05$ (15).

Results and Discussion

Five treatments, each with four replicates, were evaluated using a completely randomized design (CRD).

Table 2. Summary of growth parameters under different salt treatments

Treatment	Avg. Plant Height (cm)	Avg. No. of Leaves	Avg. Leaf Area (cm^2)	Avg. No. of Fruits
Control	80.5±1.09	41±0.34	126.8±3.44	21±0.41
T1 (50 mM)	75.3±1.09	39±0.43	117.9±3.12	19±0.32
T2 (100 mM)	66.1±1.07	37±0.45	104.2±3.05	17±0.27
T3 (150 mM)	62.4±0.89	34±0.23	97.1±2.89	15±0.22
T4 (200 mM)	56.7±0.84	31±0.20	90.2±2.71	14±0.21

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Plant Height
The plants' heights were measured. The average height of the normal plants was 80.5±1.09 cm. The plants became shorter as the soil's salt content rose. The average plant height decreased by approximately 29.6% from 80.5±1.09cm in the control to 56.7±0.84 cm at 200 mM NaCl. This reduction in height is probably because the high salt levels cause stress, making it harder for the plants to take in water. This, in turn, affected their ability to grow taller by limiting cell growth [8].
We found that as salt levels increased, the plants grew shorter, which matches what other studies have shown for the same and different crops [14].
Salt stress usually causes problems with water absorption, making it harder for cells to expand, and we saw this in our research [16,6]. The negative impact on plant height can also affect other parts of plant growth and health, and our results highlight how important these wider effects are [17].

Number of Leaves Per Plant
The higher the salt levels, the fewer leaves each plant had. The average number of leaves on plants under normal circumstances was 41±0.34. But at the highest salt level (200 mM), this number dropped to 31±0.020 leaves per plant. The decrease in leaf count shows that the plant changes how it uses energy and resources when under stress, which harms its growth [14].
The number of leaves and their size are important because they affect how well the plant can perform photosynthesis. Salt levels stress decreased both the number of leaves and their size, which matches findings from earlier studies [18]. The reduction might be due to the flora changing how it uses its energy and resources when it's under stress. When plants face stress, they tend to focus more on survival and less on growing leaves and stems. This helps them survive in the short term, but it can hurt their growth and how much they produce over time [18].

Leaf area (cm^2)
The size of the leaves is another important sign of how healthy and productive a plant is. The normal plants had leaves that were about 126.8±3.44 cm^2 on average. But when they were exposed to a high salt level of 200 mM, the leaf size dropped to 90.2±2.71 cm^2. This decrease in leaf size might be because the cells couldn't grow properly due to the salt stress, causing an imbalance in water and nutrients [19].

Fruit production
Tomato plants are judged by how many fruits they produce. On average, plants grown in normal conditions produced about 21 fruits per plant, with a small variation of ±0.41. However, when exposed to high salt levels (200 mM), the number of fruits dropped to about 14 per plant, with a variation of ±0.21. This decrease is probably because the plants use their energy to survive instead of producing fruit when they face tough conditions [14]. The fact that more salt leads to fewer fruits is a big problem for farming and crop yields [20]. Earlier research has demonstrated that plants exposed to salinity yield fewer fruits. This is frequently the result of the plants' inability to efficiently carry out photosynthesis and absorb nutrients. The primary activity that aids in plant growth and biomass production, photosynthesis, is probably disrupted by the imbalance brought on by salt [18].

Conclusion
The findings of this study demonstrated that increasing salinity levels significantly reduced the growth and productivity of tomato plants (*Solanum lycopersicum*) under laboratory conditions. Plant height, number of leaves, leaf area, and fruit production all declined progressively as NaCl concentration increased, with the greatest reductions observed at 200 mM NaCl. These results indicate that salinity is a major limiting factor affecting tomato growth and yield, highlighting the importance of adopting appropriate management practices to minimize the adverse effects of salt stress on tomato cultivation.

Conflict of interest. Nil

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