
# Improving the Tolerance of Citrus Rootstock C35 To the Salinity Levels of The Irrigation Water by Spraying with Alpha-Tocopherol

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**Abstract**
The research was conducted in Karbala Governorate - Al-Hindiya District - Karbala Nursery for Citrus Production, certified for the 2023 agricultural season. The goal was to examine the effect of spraying with alpha-tocopherol at three concentrations (0, 100, and 200 mg $L^{-1}$) and the salinity irrigation water levels (0, 2.5, and 5 ds/m). The results showed that the 200 mg $L^{-1}$ concentration was superior in all studied traits (plant height rate, stem diameter rate, carbohydrate content of the leaves, chlorophyll content of the leaves, N content leaf, leaf, P content, and K content), with values of 75.01 cm, 13.07 $mm^3$, 5.14 mg $g^{-1}$ dry weight, 52.74 SPAD, 2.578%, 0.433%, and 1.081%. The 5 ds/m salinity level was also The salinity level gave the lowest average score across all parameters (plant height rate, stem diameter rate, carbohydrate content of the leaves, chlorophyll content of the leaves, leaf N content, leaf P content, and leaf K content), where it reached 61.79 cm, 11.43 mm, 4.13 mg/g dry weight, 43.06 SPAD, 1.512%, 0.313%, and 0.808%. The interaction treatment between the concentration of 200 mg/L of alpha-tocopherol and 0 dS/m of salinity level was superior in all traits.

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## Introduction

The genus Citrus belongs to the Rutaceae family. Citrus trees are evergreen fruit trees cultivated for their highly nutritious fruit. Additionally, the fruit and leaves have medicinal benefits as they contain citric acid and ascorbic acid. The method of citrus propagation consists of two parts: scion and rootstock There are several citrus rootstocks that differ in their growth characteristics, yield, and resistance to diseases and environmental conditions. One such rootstock is C-35 Cartage, a hybrid bred at the California University and released and approved for cultivation in 1987. It results from crossing Ruby Blood orange with *Poncirus trifoliata*. It is an excellent rootstock for dwarfing trees, resistant to Tristeza (a type of rapid decline disease), fungal diseases, and tolerant of salinity and alkaline soils. Aims of the research ( Abbasi, 2015 ) Salt stress is considered one of the most significant abiotic stresses limiting crop production, particularly in arid and semi-arid regions. Reports indicate that approximately the Earth's land area 7% and its arable land 20% are affected by high salinity. Therefore, reclaiming salt-affected lands is crucial, as salts are increasingly encroaching on arable land. The initial plant response to salt stress is a decrease in surface leaf growth, tailed by a expansion cessation as the intensifies of stress. Growth then resumes once stands stress relieved. processes Metabolic, such as, lipid metabolism, synthesis protein and photosynthesisare also affected by salt stress. Salinity is responsible for various types of stress, such as osmotic, ionic, and oxidative stress, as well as imbalances hormonal. stress Osmotic results from an increase in sodium ($Na^+$) and chloride ($Cl^-$) ions in soil, whiech reduces osmotic potential and impairs water, nutrient uptake. Under salt stress, compounds with low molecular weights, known as compatible solvents, accumulate. These compatible solvents include proline, glycine, betaine, sugars, proteins, polyols, and others. These solvents do not interfere with normal biochemical reactions and help plants build their stress resistance. (Ethbeab, 2018).

Tozlu *et al*. (2000) demonstrated a negative linear relationship between plant vegetative characteristics and salt concentration. Irrigating them with sodium chloride solutions at concentrations of 30-120 mM resulted in a 30-80% decrease in the height and diameter of the stems of trifoliate orange (Puncirus trifoliata) seedlings. Najeh (2005) found that the vegetative growth of apricot seedlings decreased with increasing salinity of the propagation medium (2-8 dS/m³). This resulted in a decrease in seedling height, stem diameter, leaf chlorophyll content, and nutrient concentration in the leaves, as well as a decrease in soil salinity. The results obtained by Khalil (2004) also indicate a negative linear relationship between salt concentration and the average vegetative and chemical characteristics of orange seedlings.

Tocopherol is a compound chemical going to the vitamin E gruop, primarily bent in photosynthetic plants. It is one of the vitamins used to mitigate salinity effects. Alpha-tocopherol is a fat-soluble isoprenoid from the tocoromanol family, synthesized mainly in photosynthetic organisms (Fritsche *et al*., 2017) [10]. Tocopherols are of great importance as they work synergistically with tocotrienols, the only natural compounds exhibiting vitamin E activity, and are essential nutrients (Traber and Sies, 1996). Plants treated with alpha-tocopherol exhibit stress tolerance and antioxidant protection against various stressors (Kumar *et al*., 2012) [14].

Tocopherols have various physiological functions in plants, acting as antioxidants and scavenging peroxyl radicals. Their most significant function is the quenching of reactive oxygen species (Havaux *et al*., 2005; Mene-Saffrane, 2010) [12]. Other functions of tocopherols in plants include their involvement in photosynthesis, carbohydrate metabolism, cell signaling, and the plant's response to biotic and abiotic stresses (Ma *et al*., 2020). Alpha-tocopherols exhibit functions in chloroplasts at sites of lunar oxygen production, protecting them from photosynthetic activation and safeguarding the lipid membrane from photo-oxidation (Havaux *et al*., 2005) [12]. All plants contain lipophilic antioxidants such as fatty acids and carotenoids, including alpha-tocopherols, as integral components of photosynthetic membranes (Semeda *et al*., 2016).

There is a great difference in the composition content of vitamin E in tissues and according to the type of plant. For example, in citrus fruits, the concentrations of tocopherols are very limited. Tocopherols accumulate in the flavido (the colored outer part of the peel) such as tangerines, oranges, lemons, grapefruits and other less well-known types, in the range of 65-130 micrograms per gram, mainly in the form of α- or γ-tocopherol, and in varying proportions according to the type (Assefa *et al*., 2017) [2].

In a study conducted by (zakry,2017) on orange trees, spraying the trees with a-Tocophrol at three concentrations (0, 100, and 200 mg/L) resulted in a significant increase in plant height and stem diameter compared to the control treatment. Similarly, in a study conducted by Barkat (2012) [6] on orange trees, spraying them with a-Tocophrol at three concentrations (0, 75, and 150 mg/L) resulted in a significant increase in plant height and stem diameter compared to the control treatment. (Hussein *et al*,2017) concluded.

In a study conducted by (Doman,2020) [7] on Valencia orange trees, spraying the trees with a-Tocophrol at three concentrations (0, 150, and 300 mg/L) resulted in a significant increase in the average number of branches, the average number of leaves, and leaf area, in addition to a significant increase in some other vegetative growth indicators. (El-Baz,2005) also found significant differences in some vegetative growth characteristics, including the average number of branches, the average number of leaves, and leaf area, when spraying Egyptian mandarin seedlings with a-Tocophrol.

Madbouli (2017) showed that spraying Citrus Seedling Rootstocks exposed to salt stress with alpha-tocopherol led to an increase in the total chlorophyll concentration in the leaves. Similarly, Zacharoula *et al*. (2014) [19], in their study of the effect of resveratrol and its combination with alpha-tocopherol on adaptation in citrus seedlings, showed an increase in the chlorophyll and carbohydrate content of the leaves. In a study conducted by (Doman,2020) [7] on Valencia orange trees, spraying the trees with a-Tocophrol at three concentrations (0, 150, and 300 mg/L) resulted in a significant increase in the leaf content of N, P, and K, and a significant decrease in the concentration of sodium and chloride. El-Baz (2005) also found significant positive differences in the NPK leaf content when spraying Egyptian mandarin seedlings with a-Tocophrol.

## The research aims

The object of this study is to expand the C35 tolerance rootstock seedlings to irrigation water salinity by Using an antioxidant or anti-stress agent alphatocopheral.

## Materials and methods

The studied was accompanied in Karbala Governorate - Hindiya District - Karbala Nursery for Citrus Production, certified for the 2023 agricultural season., where one-year-old young c35 seedlings were used. The size seedlings were equal in size and age, the seedlings were marked with indicative signs, and 81 seedlings were brought, which were divided into three groups, with 27 seedlings representing a replicate, and 3 seedlings for each replicate. The planting soil was prepared from river sand and the soil was sterilized by exposing to direct sunlight for two weeks before planting. Then the soil was sterilized with boiling water twice and left to dry. The used soil in the experiment was examined to determine some physical and chemical properties,

**Table 1:** chemical, physical possessions of soil before starting the research

| Property | Parameter | Measuring Unit | Value |
|---|---|---|---|
| Soil separators | Sand | $g \cdot kg^{-1}$ | 812 |
| | Silt | $g \cdot kg^{-1}$ | 107 |
| | Clay | $g \cdot kg^{-1}$ | 84 |
| Soil texture | — | — | Sandy mixture |
| pH (1:1) | — | — | 7.38 |
| EC (1:1) | — | $dS \cdot m^{-1}$ | 1.6 |
| Elements | Nitrogen (N) | % | 0.03 |
| | Phosphorus (P) | % | 0.08 |
| | Potassium (K) | % | 0.07 |

**Experimental design:** The investigate was designed as experiment factorial according to a (RCBD) with three repetitions. The experiment included two factors: the first factor was alphatocopheral, with three concentrations (0, 100, 200 $mg.L^{-1}$), and the second factor was calcium oxide, Irrigation water salinity levels with three concentrations: (0, 2.5, 5 ds/m) (AL Raoy and Khalafallah, 2000).

**Statistical analysis:** The results were analyzed, and the factors were tested with their interactions using Genstat statistical program, and the differences between the means were compared to least difference significant (L.S.D) test at 0.05 level

## Result

### Plant height rate

**Table 2:** Effect of alphatocopheral spraying and water salinity irrigation levels and interaction on seedling height C35 cm.

| Alpha-tocopherol | Salinity 0 | Salinity 100 | Salinity 200 | Mean | LSD (Interaction) | LSD (Alpha-tocopherol) | LSD (Salinity) |
|---|---|---|---|---|---|---|---|
| 0 | 70.88 | 80.22 | 83.19 | 78.09 | 2.01 | 1.11 | 1.11 |
| 2.5 | 66.92 | 74.58 | 77.52 | 73.00 | | | |
| 5 | 50.17 | 70.89 | 64.32 | 61.79 | | | |
| Mean | 62.65 | 74.93 | 75.01 | | | | |

The results shown in Table 2 showed that there are differences significant between the concentrations of alpha-tocopherol, where the 200 mg/L was significantly superior to the other concentrations (0 and 100 mg/L) and gave the highest plant height of 75.01 cm. While the contrast treatment (0 ml $L^{-1}$) gave the lowest normal of height plant with 62.65 cm.

It is clear from the table 2 results that there are differences significant among irrigation salinity water levels, of 0 ds/m was significantly superior to the other concentrations and gave the plant stature of 78.09 cm. While the comparison treatment with 5 ds/m gave the lowest average of plant height, 61.79 cm.

The interactions of table 2 also showed significant differences between the experimental factors, as the interaction consisting of 200 mg/L of alpha-tocopherol and salinity level 0 ds/m was larger and provided the highest degree of height plant, 83.19 cm. While the interaction treatment consisting of 0 mg/L of alpha-tocopherol and a salinity level of 5 ds/m was recorded, the minimum average height plant was 50.17 cm.

### Stem diameter rate

**Table 3:** The effect of spraying alpha-tocopherol and water irrigation levels salinity and interaction on average diameter of main stem of C35 seedlings mm.

| Alpha-tocopherol | 0 Salinity | 100 Salinity | 200 Salinity | Mean |
|---|---|---|---|---|
| 0 | 11.17 | 12.75 | 13.99 | 12.63 |
| 2.5 | 10.99 | 12.44 | 13.11 | 12.18 |
| 5 | 10.00 | 12.19 | 12.11 | 11.43 |
| Mean | 10.72 | 12.46 | 13.07 | — |
| LSD (0.05) | Interaction: 0.08 | Alpha-tocopherol: 0.04 | Salinity: 0.04 | — |

The results showed on Table 3 that there are differences significant between the concentrations of alpha-tocopherol, where 200 mg. L-1 concentration was significantly superior to the other concentrations (0 and 100 mg/L) and gave the highest plant height of 13.07 mm. While the treatment comparison (0 mg/L) gave lowest average stem diameter with 10.72 mm.

It is clear from table 3 results that there are differences significant between irrigation water salinity levels, and 0 ds/m was significantly superior to the other concentrations and gave the stem diameter a height of 12.63 mm. While the comparison treatment with 5 ds/m gave the lowest average of plant height, 11.43 mm.

The interactions of table 3 also showed significant differences between the experimental factors, as the interaction consisting of 200 mg/L of alpha-tocopherol and salinity level 0 ds/m was superior and gave the maximum rate of diameter stem, 13.99 mm. While the interaction treatment consisting of 0 mg/L of alpha-tocopherol and salinity level 5 ds/m was recorded, the minimum average of plant height was 10.00 mm.

### Carbohydrate content of the leaves.

**Table 4:** The effect of spraying alpha-tocopherol and irrigation water salinity levels Interaction on the rate of carbohydrate content of leaves of C35 seedlings ($mg.g^{-1}$ dry weight).

| Alpha-tocopherol | 0 Salinity | 100 Salinity | 200 Salinity | Mean |
|---|---|---|---|---|
| 0 | 4.22 | 5.25 | 5.56 | 5.01 |
| 2.5 | 4.17 | 4.91 | 5.22 | 4.76 |
| 5 | 3.74 | 4.01 | 4.66 | 4.13 |
| Mean | 4.01 | 4.72 | 5.14 | — |
| LSD (0.05) | Salinity: 1.00 | Interaction: 0.45 | Alpha-tocopherol: 0.45 | — |

The results showed in Table 4 that present important differences between the concentrations of alpha-tocopherol, where 200 mg. L-1 concentration was significantly superior to the other concentrations (0 and 100 mg/L). The highest concentration of carbohydrates is in the leaves. 5.14 mg/g dry weight. While the treatment comparison (0 mg/L) provided the lowest average stem width with 4.01 mg/g dry weight. It is clear from the outcomes of the table that was differences significant between irrigation water salinity levels, and 0 ds/m was significantly greater to the other concentrations, gave highest concentration of carbohydrates in the leaves. of 5.01 mg/g dry weight While the comparison treatment with 5 ds/m gave the lowest average of The highest concentration of carbohydrates is in the leaves. 4.13 mg/g$^{-1}$ dry weight. The interactions of table 4 also showed significant differences between the experimental factors, as the interaction consisting of 200 mg/L of alpha-tocopherol and salinity level 0 ds/m was superior and offered highest rate diameter stem, 5.56 mg/g dry weight. While the interaction treatment consisting of 0 mg/L of alpha-tocopherol and salinity level 5 ds/m was recorded as the minimum average, the highest concentration of carbohydrates is in the leaves. was 3.74 mg/g dry weight.

### Chlorophyll content of the leaves

**Table 5:** The effect of spraying alpha-tocopherol and irrigation water salinity levels and interaction on the rate of chlorophyll in the leaves of seedlings C35 SPAD.

| Alpha-tocopherol | 0 Salinity | 100 Salinity | 200 Salinity | Mean |
|---|---|---|---|---|
| 0 | 49.12 | 52.15 | 57.25 | 52.84 |
| 2.5 | 46.47 | 53.18 | 55.14 | 51.59 |
| 5 | 40.74 | 42.59 | 45.85 | 43.06 |
| Mean | 45.44 | 49.30 | 52.74 | — |
| LSD (0.05) | Interaction: 3.26 | Salinity: 1.66 | Alpha-tocopherol: 1.66 | — |

The results showed at Table 5 that there are differences significant between the concentrations of alpha-tocopherol, where 200 mg. L-1 concentration was significantly superior to the other concentrations (0 and 100 mg). L$^{-1}$) presented concentration chief of chlorophyll in leaves. 52.74. SPAD. While treatment comparison (0 mg/L) provided the lowest average stem diameter with 45.44 SPAD.

It is the clear results of table that was significant differences between irrigation water salinity levels, and 0 ds/m was significantly bigger to the other concentrations and gave the highest concentration of chlorophyll in the leaves. of 52.84 SPAD While the comparison treatment with 5 ds/m gave the lowest average, the highest concentration of chlorophyll is in the leaves. 43.06 SPAD. The interactions of table 5 also showed significant differences between the experimental factors, as the interaction consisting of 200 mg/L of alpha-tocopherol and salinity level 0 ds/m was superior and offered the highest rate in stem diameter, 57.25 SPAD. While the interaction treatment consisting of 0 mg/L of alpha-tocopherol and salinity level 5 ds/m was recorded as the minimum average, concentration highest of chlorophyll is in leaves, it was 40.74 SPAD.

### Leaf N content

**Table 6:** The effect of spraying alpha-tocopherol and irrigation water salinity levels and interaction on the rate of N content of leaves of seedlings C35%.

| Alpha-tocopherol | 0 Salinity | 100 Salinity | 200 Salinity | Mean |
|---|---|---|---|---|
| 0 | 1.003 | 1.783 | 2.983 | 1.923 |
| 2.5 | 1.001 | 1.533 | 2.531 | 1.688 |
| 5 | 0.977 | 1.340 | 2.221 | 1.512 |
| Mean | 0.993 | 1.558 | 2.578 | — |
| LSD (0.05) | Interaction: 0.06 | Alpha-tocopherol: 0.03 | Salinity: 0.03 | — |

The results showed at Table 6 that there are significant changes between concentrations of alpha-tocopherol, where 200 mg. L-1 concentration was significantly superior to the other concentrations (0 and 100 mg/L), charitable the highest concentration of Nitrogen in leaves. 2.578%. While the control treatment (0 mg/L) provided the lowest average stem diameter with 0.993%. the results of table 6 that were significant differences between irrigation water salinity levels, 0 ds/m was significantly greater to the other concentrations and gave highest concentration of N in the leaves. of 1.923% While the comparison treatment with 5 ds/m gave the lowest average, the highest concentration of chlorophyll is in leaves. 1.512 %.

## Leaf p content

**Table 7:** The effect of spraying alpha-tocopherol and irrigation water salinity levels Interaction on the average leaf P content of seedlings of the C35 branch. Plant.

| Alpha-tocopherol | 0 Salinity | 100 Salinity | 200 Salinity | Mean |
|---|---|---|---|---|
| 0 | 0.405 | 0.455 | 0.543 | 0.468 |
| 2.5 | 0.354 | 0.421 | 0.417 | 0.397 |
| 5 | 0.247 | 0.353 | 0.341 | 0.313 |
| Mean | 0.335 | 0.409 | 0.433 | — |
| LSD (0.05) | Interaction: 0.02 | Alpha-tocopherol: 0.01 | Salinity: 0.01 | — |

The results showed at Table 7 that were differences substantial between the concentrations of alpha-tocopherol, where the 200 mg/L concentration was meaningfully higher to others (0 and 100 mg/L) and gave the highest concentration of p in the leaves. 0.433%. While the control treatment (0 mg/L) gave the lowest average stem diameter with 0.335%.
It is clear from the Table 7 results that were significant differences between irrigation water salinity levels of 0 dS/m, which was superior significantly of other concentrations, and gave highest concentration of carbohydrates in the leaves. of 0.468 % While the comparison treatment with 5 ds/m gave the lowest average, the highest concentration of p is in the leaves. 0.313%. The interactions of table 7 also showed significant differences between the experimental factors, as the interaction consisting of 200 mg/L of alpha-tocopherol and salinity level 0 ds/m was superior and gave the highest p, 0.543%. While the interaction treatment consisting of 0 mg/L of alpha-tocopherol and salinity level 5 ds/m was recorded as the minimum average, the highest concentration of p is in the leaves. was 0.247%.

## Leaf k content

**Table 8:** The effect of Alpha-Tocopherol spraying and irrigation water salinity levels Interaction on the average leaf K content of seedlings of the C35 branch. Plant.

| Alpha-tocopherol | 0 Salinity | 100 Salinity | 200 Salinity | Mean |
|---|---|---|---|---|
| 0 | 0.824 | 0.991 | 1.212 | 1.009 |
| 2.5 | 0.672 | 0.947 | 1.110 | 0.909 |
| 5 | 0.654 | 0.844 | 0.923 | 0.808 |
| Mean | 0.716 | 0.927 | 1.081 | — |
| LSD (0.05) | Interaction: 0.20 | Alpha-tocopherol: 0.10 | Salinity: 0.10 | — |

The results showed on (Table 80 that there are significant differences between the concentrations of alpha-tocopherol, where 200 mg. L-1 concentration was significantly superior to the other concentrations (0 and 100 mg/L). It gave the highest concentration of K in the leaves. 1.081%. While the control treatment (0 mg/L) presented the lowest average stem diameter with 0.716%.
The results of the table that were significant differences between irrigation water salinity levels, and 0 ds/m were superior significantly to other concentrations and gave the uppermost concentration of carbohydrates in the leaves. of 1.009 % While the comparison treatment with 5 ds/m gave the lowest average, the highest concentration of K is in the leaves. 0.808 %. The interactions of table 8 also showed significant differences between the experimental factors, as the interaction consisting of 200 mg/L of alpha-tocopherol and salinity level 0 ds/m was superior and gave the highest K, 1.212%. While the interaction treatment consisting of 0 mg/L of alpha-tocopherol and salinity level 5 ds/m was recorded as the minimum average, the uppermost concentration of phosphate is in leaves, it was 0.654%.

## Discussion

The results in Tables 2 and 3 show an improvement in vegetative growth indicators when sprayed with alpha-tocopherol. This may be due to increased action of several enzymes and cell division, such as phosphatase, glucosidase, amylopactin, and β-amylase, as well as role in the other enzymes synthesis like α –amylase, Smirnoff lipase and protase. moreover increases macronutrients absorption, which accumulate inside plant, foremost to improved plant cell differentiation and division, maintaining chloroplasts, and influencing carbon synthesis and its products, as well as activating enzymes. The enzymes in charge of carbon synthesis and growing the strength of system root, which is a middle for manufacture of hormones plant, counting cytokinins and auxins, have a pure effect on the gift of growth vegetative. Their inclusion in contents of plant parts tips to the growth of leaf cells, an growth in seedling height and diameter, and an increase in the total leaf area. The remaining tables show that the chemical properties were positively affected progressively with increasing alpha-tocopherol concentration.
This is accredited to alpha-tocopherol effect, which is an antioxidant that defends the green membrane too chloroplasts as of photo-oxidation and creates conditions environmental suitable aimed at photosynthesis because this one transmits signals internally. The transfer of cells and electrons in the PSII photocatalytic system increases enzymes activity, including enzyme in control for photosynthesis. It also reacts with a group of unsaturated fats and obtains a stable effect in protecting the membranes and chloroplasts from photo-oxidation in plants (Maxwell and Johnson, 2000). These results are consistent with what( Madbouli, 2022) [15] reported in his study on bitter orange seedlings, and also with what Zacharoula *et al*. (2014) [19] reported in their study on several types of citrus. Furthermore, the carbohydrate content increased when treated with alpha-tocopherol, which may be attributed to its effect on increasing chlorophyll levels and delaying leaf senescence. The increased chlorophyll content in leaves after spraying with alpha-tocopherol may be due to its role as an antioxidant in protecting chloroplasts from

oxidative damage (El Bassiouny, 2005). The reason for increased (N,P,K) content in leaves is that vitamins increase the efficiency of plants in terms of carbon content and growth, and thus increase the content of manufactured materials and their transfer to the roots. These manufactured products will increase their growth and the efficiency of nutrient absorption. This contributes to the accumulation of nutrients, the most important of which is NBK (Semida *et al*., 2016) [18]. It also improves membrane permeability and increases the activity of membrane-associated enzymes, and thus protects plants by maintaining the structural integrity of the plasma membrane and increasing its effect on the absorption of mineral nutrients (Rady *et al*., 2015) [17]. Effect of levels salinity on characteristics vegetative, plant height, stem diameter, Tables (2, 3) show a decreasing decrease as salinity increases. This may be due to the effect of increased salts in the soil, which results in less water and nutrient absorption by plant. This, in turn, indications to less nutrient entrance, which destructively affects processes of photosynthesis and activities vital within the cell. This affects the efficiency of respiration and photosynthesis. Salinity is considered one of the most important reasons for this, as it increases the production of free radicals, which in turn leads to the disturbance of cellular food production and oxidation of some structures internal of cell gears such as the cell wall. pressure Osmotic growths with increasing salinity, which information to a reduction in water potential. This in turn delays the transport of water through system root, which is clearly reflected in the indicators of growth vegetative. Or perhaps this reduction is caused by sodium ions accumulation and the chloride reaching a certain toxicity degree. This causes a decrease in meristematic tissue activity and prevents cell division and elongation (Azevedo *et al*, 2017) [4]. There is also a decrease in the concentration of macronutrients in the leaves (nitrogen, phosphorus and potassium percentage in leaves). This may be due to the fact that the salinity of the irrigation water leads to an increase in the osmotic pressure of the soil solution, thus negatively affecting the uptake of water and nutrients necessary for the plant, or through direct competition between chlorine and nitrogen and the displacement of nitrate uptake, or through indirect competition by altering the permeability properties of plasma membranes or by affecting membrane proteins (Gimeno *et al*., 2010) [11]. These results are consistent with those reported by Banuls (1992). The finding that increasing salt concentrations lead to a decrease in nutrient availability to plants is consistent with the findings of Khalil (2004) in his study of the effect of irrigation water salinity on the growth of bitter orange seedlings at levels of 2, 4, and 6 dS/m³. He found that increasing the salinity of irrigation water reduces the (N) nitrogen, (P) phosphorus and (K) potassium content of leaves. This also aligns with the findings of ( Attilla,1987) [3] who reported that irrigating citrus rootstocks with water at a salinity of 5 dS/m³ resulted in a decrease in macronutrients in the leaves.

## Conclusion

After discussing and interpreting the experimental results, we conclude that spraying citrus rootstock C35 with alpha-tocopherol had a positive effect on vegetative growth, increasing all studied vegetative characteristics. Conversely, salinity levels negatively impacted all vegetative characteristics and the nutrient content of the leaves. Based on these findings, we recommend applying alpha-tocopherol as a foliar spray to citrus rootstock C35, as well as to other citrus rootstocks and fruit seedlings, since it has been proven to be an antioxidant and helps plants mitigate salinity stress.

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