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EFFECT OF SALINITY AND SALICYLIC ACID ON SOME VEGETATIVE GROWTH CHARACTERISTICS AND CHEMICAL CONTENT OF *FICUS CARICA* L. SEEDLINGS

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Abstract:
The experiment was carried out with the aim of determining the effect of salicylic acid at concentrations (0,50,100) mg/L on fig seedlings exposed to salt stress through treatment with concentrations (0,50,100,150) mmol/L of sodium chloride salt.
A significant decrease in some growth characteristics (seedling height and stem diameter) was noted from the results with increasing concentrations of salicylic acid. However, treatment with concentrations of salicylic acid led to improved seedling growth, especially when treated with 100 mg/L. The results showed a decrease in the level of dry matter and total chlorophyll. And carbohydrates with an increase in salinity concentrations. Treatment with salicylic acid led to an increase in the level, and the highest levels were reached when spraying with a concentration of 100 mg/L of salicylic acid. As for the concentration of proline, it increased with an increase in salinity concentrations, but it decreased when sprayed with salicylic acid with a concentration of 100 mmol/L.

Keywords: *Ficus Carica* L., Salicylic acid, Total chlorophyll, Total carbohydrates, proline.

INTRODUCTION

Ficus Carica L. belongs to the mulberry family Moraceae and its original home is West Asia and its cultivation has spread in the Mediterranean basin (Harrisson, 2005; Herre et al., 2008). The fig tree is classified as a sub-tropical tree with interlocking branches and leaves that are palm-shaped or lobed. (Cook and Rasphus, 2003; Ronsted et al., 2005). Soil salinity and irrigation water are among the main problems hindering agricultural development, especially in semi-arid areas where temperatures rise and salinity increases (Sanwal et al., 2022), as they reduce the growth and production of plants as a result of the osmotic effect, nutritional imbalance, or stress. Watery inside the leaf and an increase in reactive oxygen species (ROS) (Tuteja, 2007; Sytar *et al.*, 2018). As a result, the sustainable development strategy includes stimulating cultivated plants to resist or tolerate stress through treatment with plant hormones that have a role in resisting salt and biotic stress (Pokotylo *et al.* ., 2021; Verma and Agrawal, 2017) Salicylic acid is considered one of the plant hormones with a phenolic nature, and it plays an important role in plant growth and development by stress (Khan et al., 2015; Peng *et al.*, 2021) and whether it is added to the hydroponic solution or Spraying or using the soil has protected the plant against many abiotic stresses by causing many processes that have a role in the mechanism of tolerance to those conditions (Miura and Tada, 2014; Klessig *et al.*, 2016). Adding it to a solution of hydroponics, spraying, or soil has protected the plant against many abiotic stresses by causing many processes that have a role in increasing the plants' tolerance to those conditions (Miura and Tada, 2014; Klessig *et al.*, 2016). The study aims to identify the role of foliar spraying of salicylic acid in reducing the harmful effect of sodium chloride salinity on plants

MATERIAL AND METHODS

The study was conducted using fig seedlings after selecting two-year-old seedlings of homogeneous vegetative growth, planted in 14 kg bags containing sandy silty mixture soil. The initial properties of the soil were determined according to the methods described in (Black, 1965; Herbert *etal.* 1971 Page *et al.*, 1982). As shown in Table (1).

The study included 12 treatments, which are an interaction between two factors. The first factor represents four irrigation water salt levels (0, 50, 100, 150) mmol/L using sodium chloride salt at equal intervals until saturation. The second factor is spraying seedlings with three concentrations of salicylic acid, which are (0, 50, 100) mg/L, one spray per week. The study was carried out as a factorial experiment according to a completely randomized block design, with three replicates for each treatment (Al-Rawi, 2000).

Table (1) Some physical and chemical properties of soil used in agriculture

Soil properties	Units of measurement
pH (1:2)	7.3
EC (1:2)	2.4
Na+	3.52(Meq/L)
K+	1.58(Meq/L)
Ca++	3.25(Meq/L)
Mg++	2.76(Meq/L)
Cl-	4.82(Meq/L)
HCO_3^-	1.93(Meq/L)
SO_4^-	$1.54^{(Meq/L)}$
PO_4^{--}	0.35%
$CaCO_3$	6.7%
Organic Matter	0.507%
Sand	92.0%
Clay	5.2%
Silt	2.1%
Texture	Sandy
Field capacity	25%

Studied attributes

1- Plant height (cm)

The length of the main stem was measured from its contact with the soil to the top of the stem using a graduated tape.

2- stem diameter (cm)

It was measured using a Vernier caliper, and the average stem diameters of all replicate plants were recorded.

3- Number of papers

The number of fully developed leaves of the seedling was counted.

4- Estimating the percentage of dry matter of the vegetable mass

The dry matter was measured by taking 5 leaves from each seedling and calculating their fresh weight with a sensitive balance. Then they were placed in an electric oven at a temperature of 70°C for 72 hours, and the percentage was calculated according to the following equation:

5-Measurement of total chlorophyll concentration (mg/100 g fresh weight)

Total chlorophyll pigment in leaves was estimated according to the method described by (Howertiz, 1975).

6- Estimation of carbohydrate concentrations (mg/100 g)

It was estimated using the method (Herbert et al., 1970).

7- Estimation of proline concentrations

The method of (Betes et al., 1973) was followed to estimate proline in plant leaves.

RESULTS AND DISCUSSION

Table (2) indicates the effect of irrigation with sodium chloride salt on the height rates of fig seedlings. It is clear from the table that increasing the concentration of sodium chloride led to a decrease in stem height, as the control treatment recorded the highest height of the main stem of the seedling, with a significant difference from the rest of the treatments, as it reached 88.77. (cm), while the 150 mmol/L treatment obtained the lowest stem height, reaching (72.00) cm. The reason for the decrease in growth at high salt levels is attributed to the decrease in the readiness of the elements necessary for plant growth with increasing salinity levels (Ramoliya et al., 2006), due to an imbalance. Nutrients with excessive salt stress and ionic imbalance cause an imbalance in hormonal balance and vital activities, in addition to osmotic effects that reduce the water absorbed by the roots, which affects the process of elongation and cell division, which negatively affects the rate of plant height (Villagra and Cavagnara, 2005), and the results agree. With (El-Dabh et al., 2011).

The results in Table 2 indicate the effect of treatment with salicylic acid on the height of seedlings, as it is clear from the table that there was a significant increase in the height of seedlings with increasing salicylic acid concentration, as it reached (73.24) cm in the control treatment before adding SA, while it became (85.17) cm when sprayed with (100) mg. / liter of salicylic acid.

As the table showed, the effect of the interaction between salinity and salicylic acid was significant, and the highest stem height was observed when the control treatment was interacted with the concentration (100) mg/L of SA, which amounted to 94.67 cm, while the lowest plant height was when the interaction between the concentration was 150 mmol/L of salt. And not spraying with SA, which reached (66.33) cm

The use of salicylic acid at concentrations of (50 and 100) mg/L led to an increase in seedling growth rates. This may be due to the encouraging effects of plant growth and resistance to salinity, which may be due to the positive role of salicylic acid in regulating osmotic potential by regulating pressure potential and water potential, which increases The ability of cells to withdraw water from the growth medium, thus increasing plant growth and sustaining cell elongation (Yassin, 2001). Salicylic acid also has an important role in protecting the root system and thus forming an active root system in delivering nutrients to the plant, which contributes to increasing the growth rate. Plant (Stevens et al., 2006) and the results are consistent with(Movahhedi-Dehnavi *et al.*, 2019) .

Table (2) The effect of sodium chloride salinity and salicylic acid on the growth rates of fig seedlings

Salt concentrations (mmol/L)	**Salicylic acid concentrations (mg/L)**			**Effect rates of salt treatments**
	0	**50**	**100**	
0	**81.30**	**90.36**	**94.67**	**88.77**
50	**74.00**	**75.65**	**87.67**	**79.11**
100	**71.33**	**74.00**	**82.32**	**75.77**
150	**66.33**	**73.67**	**76.00**	**72.00**
Effect rate of salicylic acid	**73.24**	**78.42**	**85.17**	

L.S.D(P<0.05)

The results in Table (3) indicate a significant decrease in stem diameter rates with increasing concentrations of sodium chloride salt, as the control treatment recorded the highest rate of stem diameter, with a significant difference from the rest of the treatments, as it reached (0.521) cm, while the lowest rate was recorded in the 150 mmol/L treatment and amounted to (0.282) cm. This is due to the large accumulation of sodium ions hindering the transport of ions (Mg, Ca, K, NH4) in the cell membranes, which leads to an imbalance in the permeability of the cell membranes and the nutrient balance in the plant, leading to a decline in vegetative growth characteristics as well as an imbalance in the hormonal balance (Noreen et al., 2016, Gupta et al., 2020; Maryam et al., 2023; Jindal et al., 2023)

It is clear from the table that there is a significant increase in stem diameter with increasing salicylic acid concentration, as it reached (0.290) cm in the control treatment before adding SA, while it became (0.459) cm when sprayed with (100) mg/L of salicylic acid.

The table also showed that the effect of the interaction between salinity and salicylic acid was significant. The highest stem diameter was observed when the control treatment was interacted with the concentration (100) mg/L of SA, which amounted to (0.710) cm, while the lowest stem diameter was observed when the concentration was interacted with 150 mmol/L. Of salt and not spraying with SA, which amounted to (0.250) cm.

The positive role of SA in reducing salinity damage may be due to the growth-promoting effects of this hormone due to the increased plant content of auxins and cytokinins and its effect on cell division and expansion Shakirova et al., 2003; Fujikura et al., 2020) as well as its role in stimulating the enzymes responsible for the photosynthesis process (Assche et al., 2010; Kaur et al., 2017; Li et al., 2019; Lu et al., 2018). The results are consistent with (Fayaz and Bazuid, 2014).

Table (3) The effect of sodium chloride salinity and salicylic acid on stem diameter rates of fig seedlings

Salt concentrations (mmol/L)	**Salicylic acid concentrations (mg/L)**			**Effect rates of salt treatments**
	0	**50**	**100**	
0	**0.321**	**0.532**	**0.710**	**0.521**
50	**0.303**	**0.516**	**0.535**	**0.451**
100	**0.286**	**0.345**	**0.317**	**0.316**
150	**0.250**	**0.320**	**0.276**	**0.282**
Effect rate of salicylic acid	**0.290**	**0.428**	**0.459**	

L.S.D(P<0.05)

Table (4) indicates the effect of irrigation with sodium chloride salt on the dry matter percentages. It is clear from the table that increasing the sodium chloride concentration led to a decrease in the dry matter percentages, as the control treatment recorded the highest dry matter percentage, with a significant difference from the rest of the treatments. It reached (25.944)%, while the 150 mmol/L treatment had the lowest percentage, reaching (22.307)%.

The results in Table 2 indicate the effect of treatment with salicylic acid on the dry matter percentages, as it is clear from the table that there was a significant increase in the dry matter percentages with increasing salicylic acid concentration, as it reached (20.165)% in the control treatment before adding SA, while it became (26.182)% when spraying. B (100) mg/L of salicylic acid.

The table also showed that the effect of the interaction between salinity and salicylic acid was significant, and the highest percentage was observed when the control treatment was interacted with the concentration (100) mg/L of SA, which amounted to (29.092)%, while the lowest percentage was observed when the concentration was interacted with 150 mmol/L. of salt and not spraying with SA, which amounted to (17.773)%.

Table (4) The effect of sodium chloride salinity and salicylic acid on dry matter rates of fig seedlings

Salt concentrations (mmol/L)	Salicylic acid concentrations (mg/L)			Effect rates of salt treatments
	0	50	100	
0	22.513	26.227	29.092	25.944
50	20.210	25.527	26.861	24.199
100	20.167	25.162	24.553	23.294
150	17.773	24.927	24.222	22.307
Effect rate of salicylic acid	20.165	25.461	26.182	

L.S.D(P<0.05)

Table (5) indicates the effect of irrigation with sodium chloride salt on total chlorophyll rates. It is clear from the table that increasing the concentration of sodium chloride has led to a decrease in chlorophyll rates, as the control treatment recorded the highest rate, with a significant difference from the rest of the treatments, as it reached (1.884) mg/ 100 gm fresh weight, while the 150 mmol/L treatment obtained the lowest percentage, reaching (1.178) mg/100 gm fresh weight.

The results in Table 2 indicate the effect of treatment with salicylic acid on the rate of chlorophyll. It is clear from the table that there was a significant increase in the rates of total chlorophyll with an increase in the concentration of salicylic acid, as it reached (0.905) mg/100 g in the control treatment before adding SA, while it became (1.773)% when spraying. B (100) mg/L of salicylic acid.

The table also showed that the effect of the interaction between salinity and salicylic acid was significant, and the highest total chlorophyll rate was observed when the control treatment was interacted with the concentration (100) mg/L of SA, which amounted to (2.513) mg/100 g, while the lowest total chlorophyll rate was observed when the concentration was 150. mmol/L of salt and not spraying with SA, which amounted to (0.813) mg/100g.

Table (5) The effect of sodium chloride salinity and salicylic acid on total chlorophyll rates (mg/100g)

Salt concentrations (mmol/L)	Salicylic acid concentrations (mg/L)			Effect rates of salt treatments
	0	50	100	
0	1.01	2.131	2.513	1.884
50	0.917	2.027	2.127	1.690
100	0.880	1.512	1.145	1.179
150	0.813	1.413	1.308	1.178
Effect rate of salicylic acid	0.905	1.770	1.773	

L.S.D(P<0.05)

Table (6) indicates the effect of irrigation with sodium chloride salt on carbohydrate rates. It is clear from the table that increasing the sodium chloride concentration led to a decrease in carbohydrate rates, as the control treatment recorded the highest rate, with a significant difference from the rest of the treatments, as it reached (57.39) mg/100 g. Fresh weight, while the 150 mmol/L treatment had the lowest percentage, reaching (42.04) mg/100 gm fresh weight.

The results in Table (6) indicate the effect of treatment with salicylic acid on the carbohydrate rate, as it is clear from the table that there was a significant increase in the carbohydrate rates with increasing salicylic acid concentration, as it reached (46.27) mg/100 g in the control treatment before adding SA, while it became (59.87)% when Spraying with (100) mg/L of salicylic acid.

The table also showed that the effect of the interaction between salinity and salicylic acid was significant, and the highest carbohydrate rate was observed when the control treatment was interacted with the concentration (100) mg/L of SA, which amounted to (63.24) mg/100 g, while the lowest rate was observed when the concentration was interacted with 150 mmol/L. A liter of salt and not spraying with SA, which amounted to (44.15) mg/100g. he significant decrease in the concentrations of total chlorophyll, total carbohydrates, and total protein in the leaves may be due to the inhibition of the Co2 fixation process due to the increase in Na+ and its toxic effect, which leads to the inhibition of the activity of enzymes, especially the Rabisco enzyme (R.U.b.p) and the Carboxylase enzyme (P.E.p), which affects the process of photosynthesis necessary for the production of... Carbohydrate materials also destroy the proteins responsible for the formation of the chlorophyll molecule and increase the Chllorophyllase enzyme, in addition to the fact that the sodium ion causes deformation of the chloroplasts (Pan et al., 2021; Ashraf and Harris, 2013; Ali *et al.*, 2021), and through The results showed that salicylic acid has a positive and significant effect in alleviating these harmful effects of salinity. This may be attributed to its ability to stimulate the construction of chlorophyll pigments, regulate the work of stomata, and its role in maintaining the enzymatic activity of chloroplasts (Nazar *et al.*, 2011; Khan *et al.*, 2014).

Table (6) The effect of sodium chloride salinity and salicylic acid on carbohydrate rates (mg/100g)

Salt concentrations (mmol/L)	Salicylic acid concentrations (mg/L)			Effect rates of salt treatments
	0	50	100	
0	49.27	59.66	63.24	57.39
50	46.88	58.59	62.01	55.82
100	44.78	56.25	57.50	52.84
150	44.15	55.23	56.76	42.04
Effect rate of salicylic acid	46.27	57.43	59.87	

L.S.D(P<0.05)

Table (7) shows that increasing the salinity concentration led to a significant increase in the proline concentration of the plant at all salt concentrations compared to the control treatment. The lowest rate of proline concentration was (1.27) micrograms/g in the control treatment, while the highest concentration rate was (4.84). Micrograms/g at concentration (150) mmol/L. The results indicated a significant effect of spraying with salicylic acid, as the average concentration of proline reached (2.16) micrograms/g without adding SA, while it became (3.32) micrograms/g when spraying with (100) mg/liter of salicylic acid.

The table also showed that the effect of the interaction between salinity and salicylic acid was significant, and the highest proline rate was observed when the salt treatment (150) mmol/L interacted with the concentration (100) mg/L of SA, which amounted to (6.00) microg/g, while the lowest rate was When there was an interaction between the concentration of (0) mmol/L of salt and not spraying with SA, which amounted to (1.15) Micrograms/g.This may be due to the fact that spraying with salicylic acid has increased the proline content of the leaves, as this encourages growth by regulating the osmotic potential, which increases the ability of the cells to withdraw water from the growth medium, thus increasing the process of photosynthesis and building proteins that require the formation of amino acids, including Proline, which is involved in protein synthesis (Steven et al., 2006), and the results agree with (Rajabi et al., 2022)

Table (7) The effect of sodium chloride salinity and salicylic acid on proline rates (Micrograms/g)

Salt concentrations (mmol/L)	Salicylic acid concentrations (mg/L)			Effect rates of salt treatments
	0	50	100	
0	1.15	1.29	1.38	1.27
50	1.98	2.01	2.12	2.03
100	2.04	3.62	3.81	3.15
150	3.50	5.02	6.00	4.84
Effect rate of salicylic acid	2.16	2.98	3.32	

L.S.D(P<0.05)

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