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Comparison between two Mulberry Species for Tolerance of Salinity

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ABSTRACT

This investigation was carried out at the research farm of Horticulture Research Institute, Giza governorate. Two mulberry species (*Mours nigra* and *Morus macroura*) was treated with tap water as a control treatment and two rates of saline water (3000 and 6000 ppm). Some physical and chemical properties of the experimental soil were tested. Also, some vegetative growth and chemical composition were recorded. Results showed that, increasing salinity levels increased bulk density (BD) and hydrulic conductivity (Ksat), while total soil porosity (TP) was decreased by increasing it in both seasons for total soil porosity and in second seasons only for hydraulic conductivity. pH and EC increased by increasing salinity levels, while organic matter (OM), nitrogen (N) and potassium (K) content was decreased by increasing salinity levels. Stem length, stem diameter, leaf numbers, root length and root numbers of *Mours nigra* and *Morus macroura* was decreased by using the highest rates of salinity in both of season of study. The highest saline rates (6000 ppm) caused significant decreasing in Moisture percentage, chlorophyl A (Chl A), chlorophyl B (Chl B) and Carotin content, while Nitrogen percentage and Proline content significantly increasing in both Mullebry species in the two seasons of study. *Mours nigra* seedlings was more tolerances than *Morus macroura* in resistance of salinity.

Keywords: Mulberry, *Mours nigra*, *Morus macroura* , Salinity, Soil

1. Introduction

Soil salinity one of the serious environmental issues, The possibility of exploiting saline. lands becomes a vital aspect in agricultural development. The abiotic stress, drought along with salinity is expected to cause up to 50% of arable land loss worldwide (Buchanan, 2000; Mittler, 2006 and Abdelraheem *et al.,*2019). salinity is one of the main abiotic stresses that negatively influence crop productivity and quality. In Egypt the total salt affected area are about 0.9 Mha affected area are about 0.9 Mha (Bayoumi, 2019). It is estimated that nearly 19.5% of the irrigated agricultural lands are considered salt affected (Flowers and Yeo, 1995). Every year nearly 2 million hectors of agricultural lands are additionally affected by salinity (Kalaji and Pietkiewica, 1993). Salinity not only decreases the agricultural production of most crops, but also, affects soil physicochemical properties, and ecological balance of the area. The impacts of salinity included low agricultural productivity, low economic returns and soil erosion, (Hu and Schmidhalter, 2002).

Soil physical properties may be affected by increasing soil salinity so they cause fine particles to bind together into aggregates especially in case of presence Ca^{++} salts. Increasing soil pH may be deterioration the structure of soils with rising sodium content in the soil solution and aggregation on clay particles causing alkali (Rengasamy, 2006). The increasing of ESP and TSS are caused increasing on Bulk density but the effect of ESP is more in this regard. On the other hand, the increasing in ESP and TSS decreased porosity but the effect of ESP was more than TSS in this direction. The soluble cations and anions increased as a result of increasing water salinity with different rates. For instance, $SO4^{--}$ concentration in soil extract showed considerable increases as the time increases, reaching 6 fold as compared to the soils which irrigated with tap water in addition increasing of SAR (Shakir *et al.,*

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2002 and Mostafa *et al.,* 2004). The increase in the concentrations of water parameters (EC, SAR and RSC) led to an increase in EC, pH and the concentration of soluble ions exception soluble K (Abd-Elhady *et al.,* 2011).

Accumulation Salts in the agricultural land were caused a depression in vegetative growth adversely and lowering of the crop production. In case of continuation the increasing of salinity, seedling's life may be ended in addition the soils become non-suitable for production. The adverse effects of drought may be increased in presence of the salinity as it's negative role on plant growth and germination of seeds through OP (osmotic pressure) that toxic effects of chloride and sodium ions on the seed germination or by prevents uptake the water (Mehmet *et al.,* 2006). Sodication and salinization are caused a reduction in the soil productivity, lead to lowering the soil degree and if the level of Na^+ soil concentration continuous increasing, the colloidal fraction conduct may be influenced. The appearance of salinity in the soils lead to decrease of the agricultural production causing a great dropping in the world's economy (Al- Zu'bi, 2007).

Mulberry (Morus spp. L.) are a perennial trees belonging to the family Moraceae which includes 68 species, among species, *Morus nigra* (black mulberry) originated in Iran are widespread throughout world (Datta, 2002; Ercisli, 2004 and Yilmaz *et al.,* 2012). Mulberry trees are extensively grown in Brazil, India and China for uses their leaves as a food for silkworms, the mulberry cultivated area is (38 000, 280 000 and 626 000 hectares), respectively (Sanchez, 2002 and Singhal, 2009). Mulberry is a moderate tolerance to salinity and deciduous woody tree, which has great economic importance. Its leaf is used as fodder for livestock. Also, leaf is used to feed the silkworm. The fruits of mulberry have many medicinal properties in addition are highly nutritious (Vijayan, 2009).

Numerous studies indicated that edible plants play a prominent part in the maintenance of human healthcare as they are a good source of phytochemicals and (Zafra-Stone *et al.*, 2007 and Jiang and Nie, 2015). Polyphenolics and flavonols are the most common compounds in herbs with strong antioxidants and hence showed anti-inflammatory activity (Farzaei *et al.,* 2015 a, b), antiatherosclerotic, antibacterial and antiviral activities to a greater or lesser extent (Cardona *et al.,* 2013 and Wasek *et al.,*2015).

Black mulberry (*Morus nigra* L.) is rich in anthocyanins, flavonoids and polyphenols which are responsible for their anti-inflammatory activities (Padilha *et al*., 22010 and Chen *et al*., 2016) and antioxidant (Ozgen *et al.,* 2009 and Souza *et al.,* 2018). Black mulberry is used especially in fruit juice and mulberry pestil production due to its dark color and rich in anthocyanins (Gündoğdu *et al.,*2018). Beyond their culinary appeal, mulberries have garnered attention for their potential health benefits, contributing to the growing interest in incorporating these versatile berries into a balanced and nutritious diet (Zhang *et al.*, 2018).

Himalayan mulberry (*Morus macroura*) is native to Pakistan and possesses many beneficial compounds with therapeutic activities, is widely used as a traditionally medicinal plant. It contains andalasin A, mulberroside C and key active compounds which have been extracted from its wood and exhibit weak moderate antifungal and antinematodal properties (Syah *et al.,* 2000). Ethanol which extraction from the roots and stems of *Morus macroura* used for determine the potential of inhibiting the growth of pathogen microbes (Staphylococcus aureus, *Escherichia coli*, and *Candida albicans*). In addition, Bioactive diels-alder type adducts from the stem bark of *Morus macroura* showed anti-inflammation activity (Dai *et al.,* 2004). Some bioactive compounds for addressing Alzheimer's disease (AD) were extracted from fruits and leaves of *Morus macroura* (El-Hawary *et al.,* 2021).

The mulberry is considered one of the optimal tree species for afforestation projects across the countries (Wang *et al.,* 2010). As a results of the distinct similarity in acoustical tests between the mulberry's wood (*Morus alba*) and some other woods which are used for making guitar and violin, it used for making in addition to the traditional Iranian bowl shaped musical instruments such as Tar, Setar and Kamanche (Pourtahmasi and Golpayegani, 2009). Also, *Morus nigra* may serve as an alternative to oak and beech wood which used in Egypt for parquet flooring as it had a higher mechanical properties (Hassan, 2019). In this regard, *Morus nigra* utilization potential for paper manufacture and pulp (Hussain, 2020). The good quality, dynamic and structural of the mulberry,s wood are suitable for cabinet making and barrels, especially that used for the production of balsamic vinegar because it maintains the suitable qualities and properties for this type of vinegar (Vivas *et al.,* 2005 and Gündüz *et al.,* 2009).

The objective of this study was investigated the different rates of salinity on growth rate and chemical composition of two mulberry species both of *Mours nigra* and *Morus macroura*.

2. Materials and Methods

This study was carried out during two successful seasons (2021 and 2022) in the greenhouse of the tropical fruit research department in the Horticulture Research Institute, Giza governorate. The mulberry seedlings of both *Mours nigra* and *Morus macroura* species almost identical in age and size.

In April these seedlings were rotated in pots diameter 30 cm, the weight of the soil in every pot was 5.5 Kg. These plants were divided into three groups, each one containing 9 seedlings (3 replicate X 3 seedlings).

2.1. Soil analysis

The determination of organic matter (OM) and soil saturation (%) were done according to Page, (1984). The determination of soil structure factor and bulk density were done according to Dewis and Freitas, (1970). The determination of mechanical analysis was done by the international pipette method according to Kilmer and Alexander, (1949). The Collin's calcimeter method was used to determine the total carbonate according to Piper, (1950). Both the exchangeable cations and the cation exchange capacity were estimated according to Bower *et al.* (1952). The estimation of soluble ions in the soil, (N, P, K, Ca and Na content), pH and EC were done according to Jackson, (1967).

Table 1: Some physical and chemical properties of the experimental soil at the beginning of the experiment during 2021 and 2022 seasons.

Particle size distribution					Soil physical properties		
Coarse sand (%)	**Fine sand (%)**	**Silt (%)**	**Clay (%)**	**Soil texture**	**Bulk density (gm cm $^{-3}$)**	**Total porosity (%)**	**SP (%)**
68.05	25.60	3.54	2.81	Sandy	1.72	34.2	22

Soil chemical properties													
O.M (%)	**pH Soil-water suspension ratio (1:2.5)**	**EC dSm $^{-1}$**	**Soluble cations (meq L $^{-1}$)**				**Soluble anions (meq L $^{-1}$)**				**Available macronutrients (mg kg $^{-1}$)**		
			Ca^{++}	**Mg^{++}**	**Na^{+}**	**K^{+}**	**CO^{-}**	**HCO_3^{-}**	**Cl^{-}**	**SO_4^{--}**	**N**	**P**	**K**
1.14	7.75	0.47	1.03	0.97	1.31	1.00	-	1.91	1.1	1.17	38	8.2	51

Hydraulic conductivity (cmhr $^{-1}$)	8.40	**Available water %**	7.20
Field capacity % v/v	9.13	**Total porosity %**	47.5
Wilting point % v/v	1.90	**Bulk density (gm cm $^{-3}$)**	1.62

pH *: in suspension 1:2.5
EC** (ds/m), soluble cations and anions (meq L $^{-1}$) in saturated past extract

First treatment: Watered with tape water (control).
In second and third treatment we Mack mixture of salt content from sodium chloride and calcium chloride at ratio 1 to 1.
Second treatment: Irrigated with saline water 3000 ppm (3gm of the mixture per liter).
Third treatment: Irrigated with saline water 6000 ppm. (6gm of the mixture per liter).

Vegetative parameters: the following vegetative measurements for all the seedlings investigated were recorded during the two seasons of the study as follows:

1. Average stem and root length (cm).
2. Average stem diameter (cm) using a Vernier caliper.
3. Average number of leaves and root/seedlings were counted.
4. The percentage increase every six months was calculated by using the following equation (B -A \ B *100)
   A: - Value at the beginning of the experiment
   B: - Value after six months

2.2. Chemical determinations

a) Moisture percentage within the samples after being oven dried at 70 C until constant weight.

b) Photosynthetic pigments (chlorophyll (A), (B) and carotene) were colorimetrically determined in samples of sufficient fresh leaves according to Saric *et al*. (1967).

c) Proline content was colorimetrically determined in fresh leaf samples according to the methods of (Bates *et al.*, 1973)

Samples were finely ground about 0.5g dry matter was digested in 5 ml sulfuric and perchloric acid 2:1 (v/v) until the digestive solution became colourless, then transferred quantitatively to 100 ml volumetric flask. The mineral nutrients considered were determined in samples as follows:

d) Total nitrogen was determined colorimetrically according to the modified microkieldahl method as described by Pregl, (1945).

Table 2: The measurement of vegetative parameters on *Morus nigra* and *Morus macroura* seedlings at the beginning of the experiment during the 2021 and 2022 seasons.

	Stem length			Stem diameter			Leaf number		
	Morus nigra	***Morus macroura***	**Mean**	***Morus nigra***	***Morus macroura***	**Mean**	***Morus nigra***	***Morus macroura***	**Mean**
				First Season 2021					
Control	53.36	55.20	54.28	1.59	1.47	1.53	29.4	27.4	28.4
3000 ppm	51.45	56.65	54.05	1.52	1.62	1.57	29.2	25.8	27.5
6000 ppm	55.36	51.32	53.34	1.56	1.66	1.61	27.8	29.2	28.5
Mean	53.39	54.39		1.56	1.58		28.80	27.47	
				Second Season 2022					
Control	49.40	51.32	50.36	1.48	1.6	1.54	25.6	21.4	23.5
3000 ppm	47.25	52.28	49.77	1.52	1.54	1.53	23.8	21.4	22.6
6000 ppm	51.6	51.80	51.70	1.54	1.62	1.58	25.2	23.2	24.2
Mean	49.42	51.80		1.51	1.59		24.87	22.00	

Statistical analysis

The data obtained were subjected to analysis of variance, for factorial plot design in a randomized complete block with 6 treatments (3 saline water (A) X 2 mulberry species (B)). Each treatment contained 9 seedlings (3 replicated and 3 seedlings per replicated) (Snedecor & Cochran, 1980). The individual comparisons between the values obtained were made by application the method of new least significant differences (New L.S.D) at 5% level which described by (Waller and Duncan, 1969).

3. Results and Discussion

Regarding the effect of salinity levels on bulk density (g/cm^3), total porosity and hydraulic conductive, data in Table (3) showed that, increasing salinity levels increased bulk density. The values of bulk density were 1.65, 1.74 in the first season from control 1.62 (g/cm^3), in second season 1.67,1.79 (g/cm^3) from control 1.66. On the other hand, total porosity were decreased to 46.4 and 46.3 from control 47.7 % in the first season. Also, the values of the hydraulic conductive was 8.42 and 8.46 (cm/h) for the control treatment in second season. The increase in bulk density was higher in treatments of concentration NaCl. Data of the same Table showed that total soil porosity was reduced by increasing levels of the salinity levels. The decrease was higher in treatments of NaCl. This result is due to high bulk density (Shakir *et al.,* 2002) and agree with those of (Bennett *et al.*, 2019). Soluble sodium content in the studied soil is increased by increasing sodium content in soil salinity. Sodium had the adverse effect of salinity on soils. The primary physical processes associated with high sodium concentrations are soil dispersion and clay platelet and aggregate swelling. The forces that bind clay particles together are disrupted when too many large sodium ions come between them. At the time the separation occurs, the particles of clay were expand, causing soil dispersion and swellings (Zhu *et al.,* 2016). Soil dispersion causes clay particles to plug soil pores, resulting reduction of the soil permeability. Whenever soil is repeatedly wetted and dried and clay dispersion occurs, it then reforms and solidifies into almost cement-like soil with little or no structure. The three main problems caused by sodium-induced dispersion are reduced infiltration, reduced hydraulic conductivity, and surface crusting**.**

Table 3: Effect of salinity doses on soil bulk density (BD), total porosity (TP) and hydraulic conductivity (Ksat) in two seasons.

Treatments	First Season 2021			Second Season 2022		
	BD (gm/cm3)	TP%	K_{sat} (cm/h)	BD (g/cm^3)	TP %	K_{sat} (cm/h)
Control	1.62	47.7	8.40	1.66	48.1	8.83
3000 ppm	1.65	46.4	8.44	1.67	47.4	8.42
6000 ppm	1.74	46.3	8.47	1.79	47.1	8.46
New L.S.D at 5%	0.11	0.73	0.011	0.09	0.77	0.013

Data presented in Table (4) indicated that, increasing salinity in the soil caused increasing the values of EC from 0.47 to 0.70, pH from 7.75 to7.89 and non-significant, in both seasons. Organic matter and N and K were affected by increasing soil salinity which lead to decrease the organic matter percentage from 0.62 to 0.37, also N from 75 to 51 and K from 246 to 184, this results agreement with (Grattan and Grieve, 1999). N availability in the soil may be affected in case of presence the salts in soil as a resulted of impeded both immobilization processes and microbial N mineralization and due to increase the soil pH in the same trend (Hu and Schmidhalter, 2002) confirmed salinity not only decreases the agricultural production of most crops, but also, effects soil physicochemical properties, and ecological balance of the area. The impacts of salinity include increase pH and the electrical conductivity, decrease organic matter and decrease available N and P, also (Sun *et al.,* 2023). The electrical conductivity in different periods could reflect the trend of soil salinity.

Table 4: Effect of salinity doses on pH, electric conductivity (E.C.), organic matter (OM), nitrogen (N) and potassium (K) in two seasons.

Treatments	First Season 2021					Second Season2022				
	pH (1:2.5	EC (dSm^{-1})	OM (%)	N (mg Kg^{-1})	K (mg Kg^{-1})	pH	EC (dSm^{-1})	OM (%)	N (mg Kg^{-1})	K (mg Kg^{-1})
Control	7.75	0.47	0.62	75.0	246.0	7.73	0.49	0.64	78.0	241.0
3000 ppm	7.81	0.61	0.52	66.0	208.0	7.84	0.66	0.48	61.0	192.0
6000 ppm	7.86	0.63	0.40	62.0	192.0	7.89	0.70	0.37	51.0	184.0
New L.S.D at 5%	0.04	0.11	0.15	9.11	37.3	0.07	0.12	0.16	17.81	39.10

Data presented in Table (5) showed that, the values of FC, WP and AW in testing soils negative affected responded to the application of different treatments as comparatively observed with the control treatment. Field Capacity (FC) and wilting point (WP) increased from control 9.35, 9.88 and 2.18, 2.25 in two treatments 3000 and 6000 ppm, respectively, in first season and a significant . The same in second season, field capacity (FC) and wilting point (WP) increased from control 9.55, 9.97 and 2.21, 2.32 in two treatments 3000 and 6000 ppm, respectively and a significant. That confirmed by Beltrão and Ben Asher, (1997) at a higher salinity, the water content at wilting point is higher than at low salinity, resulting in an insufficient amount of available water, and, therefore, a reduced yield. Increasing of soil salinity caused unbalanced biochemical and physiological processes due to the water deficit, nutritional imbalance, oxidative stress and osmotic stress (Farrant and Costa, 2020). The assumptions suggests that, with a constant field capacity available soil water depends on the wilting point. The higher the wilting point the lower is water availability and vice versa (FAO, 1998 and Hussain *et al.,* 2018).

Table 5: Effect of salinity doses on soil physical properties on field capacity (FC), wilting point (WP) and available water (AW) in two seasons.

Treatments	First season			Second season		
	FC %	WP/ %	AW %	FC %	WP/ %	AW %
Control	9.13	1.90	7.23	9.22	1.95	7.27
B 3000	9.35	2.18	7.17	9.55	2.21	7.34
C 6000	9.88	2.25	7.63	9.97	2.32	7.65
LSD at 0.05	0.64	0.25	0.29	0.61	0.21	0.22

On other hand, the measurement of vegetative parameters of two mulbry species at the beginning of study shown in Table (2).

The data presented in Tables (6 and 7) revealed that, growth parameters (stem length, stem diameter and leaves number) of *Morus nigra* and *Morus macroura* seedlings were gradually and significantly decreased by increasing water salinity rate up to (6000 ppm). The same trend was observed in both seasons for all parameters. The highest stem length (116.27 and 101.45 cm), stem dimeter (1.80 and 1.95 cm) and leaves number (46.92 and 43.44) were recorded by control treatment with an increasing (114.20 and 98.98 %), (17.65 and 26.62 %) and (65.21 and 84.85%) for stem length, stem diameter and leaves number as compared with the beginning of the experiment in the first and second seasons, respectively. These results were in agreement with those obtained by Taiz and Zeiger, (2015). The highest concentration of water salinity (6000 ppm) was gained the lowest value for stem length, stem diameter and leaves number (92.33 and 87.13 cm), (1.64 and 1.61 cm) and (40.00 and 36.53) with increasing (79.09 and 68.52 %), (1.86 and 1.89 %) and (40.35 and 50.95%) compared with the beginning of the experiment in both seasons, respectively. The treatment of water salinity at concentration of (3000 ppm) came intermediate between the two other treatments. The same data also showed that, significant difference between two species in the first season only. *Morus nigra* gained the highest stem length (105.71 cm) with increasing (97.99 %). On other hand, stem dimeter and leaves number differed insignificantly and significantly in both seasons, respectively. *Morus nigra* gave the highest leaves number and increment percentage (44.75 and 44.79) and (55.38 and 80.09 %) in both seasons, respectively.

Table 6: Effect of salinity doses on vegetative parameters of *Morus nigra* and *Morus macroura* seedlings after six months during the 2021 and 2022 seasons.

		Stem length			Stem diameter			Leaf number		
		Morus nigra	***Morus macroura***	**Mean**	***Morus nigra***	***Morus macroura***	**Mean**	***Morus nigra***	***Morus macroura***	**Mean**
					First Season 2021					
Control		116.28	116.26	116.27	1.80	1.80	1.80	48.25	45.58	46.92
3000 ppm		104.45	97.48	100.97	1.65	1.72	1.69	46.46	41.36	43.91
6000 ppm		96.40	88.26	92.33	1.60	1.68	1.64	39.55	40.45	40.00
Mean		105.71	100.67		1.68	1.73		44.75	42.46	
New L.S.D at 5%	**A**		3.57			0.019			2.33	
	B		2.39			N.S			1.67	
	A X B		6.69			0.035			4.59	
					Second Season 2022					
Control		99.84	102.45	101.45	1.90	2.00	1.95	48.52	38.35	43.44
3000 ppm		93.22	96.42	94.82	1.65	1.66	1.66	46.45	36.42	41.44
6000 ppm		90.00	84.25	87.13	1.60	1.62	1.61	39.40	33.66	36.53
Mean		94.35	94.37		1.72	1.76		44.79	36.14	
New L.S.D at 5%	**A**		3.29			0.019			3.67	
	B		N.S			N.S			1.94	
	A X B		3.47			0.029			2.16	

Table 7: Increasing percentage of vegetative properties of *Morus nigra* and *Morus macroura* seedlings after six months during 2021 and 2022 seasons.

Species	Stem length			Stem diameter			Leaf number		
	Morus nigra	*Morus macroura*	Mean	*Morus nigra*	*Morus macroura*	Mean	*Morus nigra*	*Morus macroura*	Mean
				First Season 2021					
Control	117.91	110.61	114.20	13.20	22.44	17.65	64.11	66.35	65.21
3000 ppm	103.01	72.07	86.81	8.55	6.17	7.64	59.10	60.31	59.67
6000 ppm	74.13	71.97	79.07	2.56	1.20	1.86	42.26	38.52	40.35
Mean	97.99	85.08		7.69	9.49		55.38	54.56	
				Second Season 2022					
Control	102.10	99.62	98.98	28.37	25.00	26.62	89.53	79.20	84.85
3000 ppm	97.29	84.42	90.51	8.55	7.79	8.49	95.16	70.18	83.36
6000 ppm	74.41	62.64	68.52	3.89	0.00	1.89	56.34	45.08	50.95
Mean	90.91	82.18		13.90	10.69		80.09	64.27	

In this direction, salinity stress may be reducing productivity of mulberry plants by inhibiting photosynthesis and growth. The effect of interaction between water salinity concentration and two species (*Morus nigra* and *Morus macroura*) on vegetative growth are clear that, all the possible interactions were statistically significant. Stem length, stem diameter and leaves number ranged between (116.28 and 88.26 cm), (1.80 and 1.60 cm) and (48.25 and 39.55) with increment ranged between (117.91 and 71.97 %), (22.44 and 1.20 %) and (66.35 and 38.52%) in the first season, while the highest stem length in both seasons resulted for *Morus nigra* at the control treatment (116.28 and 99.8cm). Similar results were obtained by Tuteja, (2007); Golombek and Lüdders, (1993).

Data presented in Tables (8 and 9) showed that, all parameters of vegetative growth for the two Mulberry species after twelve months decreased significantly with increasing water salinity rate up to (6000 ppm) in both seasons. Seedlings which irrigated with water salinity of (6000 ppm) gave the lowest stem length while the highest was recorded by the control treatment in both seasons. The highest stem length (177.65 and 162.54 cm) an increase (52.77 and 2.80 %) compared with the length after three months was gained by control treatment of *Morus nigra* whereas, the lowest (103.76 and 99.79 cm) an increase (17.56 and 18.44 %) was recorded for (6000 ppm) treatment of *Morus macroura* in both seasons, respectively. The stem diameter takes a similar trend, and the highest concentration of water salinity (6000 ppm) tended to decrease stem diameter (1.65 and 1.62 cm) as compared with the control treatment (2.10 and 2.30 cm), it fluctuated between the two species (*Morus nigra* and *Morus macroura*) in both seasons, respectively. The data revealed that, there was a significant difference between two species. in the second season only. *Morus macroura* seedlings gained the highest stem diameter (1.89 cm), while the lowest value of stem dimeter had resulted by *Morus nigra* (1.84 cm). Anyhow, the stem diameter ranged between (2.11 and 1.62 cm) and (2.37 and 1.60 cm) during the two seasons, respectively. The number of leaves was markedly decreased with increasing water salinity concentration rate under the two species. The control treatment recorded the highest number of leaves (64.39 and 59.14), while the lowest number (42.3 and 36.21) was gained by (6000 ppm) in the first and second seasons, respectively. The *Morus nigra* exhibited the highest number of leaves (55.89 and 50.15) in both seasons. Total number of leaves ranged between (66.57 and 41.32) and (60.79 and 33.65) in the first and second seasons, respectively. Also, the highest leaves number were produced by the control treatment, where the lowest values are shown at the rate of (600 ppm) treatment by the two species without significant differences between them. Indicating that the concentration of slate in irrigation water is the main factor in decreasing number of leaves. The highest number of leaves (66.57 and 60.79) were recorded by control treatment and *Morus nigra*, while the lowest leaves number (41.32 and 33.65) produced by (6000 ppm) treatment for *Morus macroura* in both seasons, respectively. These results were in accordance with those obtained by Shannon *et al.* (1994) and Lakshmi *et al.* (1996).

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Table 8: Effect of salinity doses on vegetative properties of *Morus nigra* and *Morus macroura* seedlings after twelve months during2021 and 2022 seasons.

Species		Stem length *Morus nigra*	Stem length *Morus macroura*	Stem length Mean	Stem diameter *Morus nigra*	Stem diameter *Morus macroura*	Stem diameter Mean	Leaf number *Morus nigra*	Leaf number *Morus macroura*	Leaf number Mean
					First Season 2021					
Control		177.65	175.36	176.51	2.11	2.09	2.10	66.57	62.21	64.39
3000 ppm		142.56	126.82	134.69	1.72	1.76	1.74	57.83	52.57	55.20
6000 ppm		114.86	103.76	109.31	1.62	1.68	1.65	43.27	41.32	42.30
Mean		145.02	135.31		1.82	1.84		55.89	52.03	
New L.S.D at 5%	**A**	5.79			0.027			4.58		
	B	3.58			0.021			2,71		
	A X **B**	8.69			0.033			7.92		
					Second Season 2022					
Control		162.54	161,87	162.21	2.23	2.37	2.30	60.79	57.49	59.14
3000 ppm		133.71	127.39	130.55	1.68	1.67	1.68	50.91	46..58	48.75
6000 ppm		110.37	99.79	105.08	1.60	1.63	1.62	38.77	33.65	36.21
Mean		135.54	129.68		1.84	1.89		50.15	45.91	
New L.S.D at 5%	**A**	7.65			0.093			5.67		
	B	3.83			0.035			2.94		
	A X B	9.37			0.113			7.68		

Table 9: Increasing percentage of vegetative properties of *Morus nigra* and *Morus macroura* seedlings after twelve months during 2021 and 2022 seasons.

Species	Stem length *Morus nigra*	Stem length *Morus macroura*	Stem length Mean	Stem diameter *Morus nigra*	Stem diameter *Morus macroura*	Stem diameter Mean	Leaf number *Morus nigra*	Leaf number *Morus macroura*	Leaf number Mean
					First Season 2021				
Control	52.77	50.83	51.81	17.22	16.11	16.66	37.96	36.48	37.23
3000 ppm	36.48	30.09	33.39	4.22	2.32	2.95	24.47	27.10	25.71
6000 ppm	19.14	17.56	18.39	0.125	0.00	0.60	9.40	2.15	5.75
Mean	37.18	34.4		8.33	6.35		24.89	22.53	
					Second Season 2022				
Control	62.80	57.99	59.89	17.36	18.50	17.94	25.28	49.90	36.14
3000 ppm	43.43	32.40	34.34	1.81	0.60	1.20	9.60	27.89	17.63
6000 ppm	22.63	18.44	20.60	0.00	0.60	0.62	-1.59	- 0.02	- 0.87
Mean	43.65	37.41		6.97	7.38		11.96	27.03	

The available data of roots number and roots length are presented in Table (10). Data reported that, the effect of three water salinity treatments differed significantly concerning roots number and roots length in both seasons. control treatment recorded the highest roots number (26.88 and 22.05) and roots length (24.25 and 21.89 cm), while the lowest roots number (16.46 and 15.48) and roots length (14.79 and 14.09 cm) were gained by (6000 ppm) water salinity concentration treatment without significant difference between it and (3000 ppm) treatment in the first and second seasons, respectively. The data revealed significant differences between the two varieties in both seasons regarding roots number and concerning roots length it differed significantly in the second season only. *Morus nigra* species produced the highest roots number (22.70 and 18.9), while the lowest roots number (19.44 and 17.20) was gained by *Morus macroura* species in the two seasons, respectively. Roots number and length were significantly decreased with increasing water salinity concentration. Treatment (6000 ppm) produced the lowest roots number and length under the two species without significant differences between them indicating that water salinity is the important factor in decreasing roots number and length of mulberry seedling. The highest roots number (29.36 and 23.47) and roots length (23.86 and 23.25) were produced by the seedling irrigated with highest rate of salinity under *Morus nigra* variety, whereas control treatment gained the lowest roots number (15.66 and 15.21) and roots length (14.24 and 13.50) in both seasons, respectively. The growth parameters were decreased by increasing concentration of the salts. These findings are in agree with (Wulandari *et al.,* 2021).

Table 10: Effect of salinity doses on root properties of *Morus nigr*a and *Morus macroura* seedlings after twelve months during 2021 and 2022 seasons.

Species		Root numbers			Root length		
		Morus nigra	***Morus macroura***	**Mean**	***Morus nigra***	***Morus macroura***	**Mean**
				First Season 2021			
Control		29.36	24.40	26.88	23.86	24.64	24.25
3000 ppm		21.48	18.25	19.87	17.46	16.56	17.01
6000 ppm		17.26	15.66	16.46	15.34	14.24	14.79
Mean		22.70	19.44		18.89	18.48	
New	**A**		4.53			4.77	
L.S.D at	**B**		1.031			N.S	
5%	**A X B**		6.85			6.38	
				Second Season 2022			
Control		23.47	20.62	22.05	23.25	20.52	21.89
3000 ppm		17.88	15.76	16.82	18.20	17.38	17.79
6000 ppm		15.34	15.21	15.28	14.67	13.50	14.09
Mean		18.90	17.20		18.71	17.13	
New	**A**		3.63			2.54	
L.S.D at	**B**		1.025			1.053	
5%	**A X B**		3.34			3.21	

Data presented in Table (11) Showed that, the highest saline rates (6000 ppm) caused significantly decreasing in Moisture percentage in both Mulberry species in the two seasons of study. Also, there were non-significant differences between *Morus nigra* and *Morus macroura* in Moisture percentage. Chl A, Chl B and Carotin leaves tend to decrease by increasing saline rates and the rate of (3000 ppm) showed the intermediate values in this regard. On other hand, Nitrogen percentage and Proline content significantly increased in *Morus nigra* and *Morus macroura* leaves by using the highest rates of salinity.

The abovementioned results may be due to Salinity adversely affecting the growth of the mulberry, albeit the severity of which varies depending on the tolerance level of the genotype. Under higher salinity burnt like lesions appeared in the leaves (Vijayan *et al.,* 2008 a). Adverse effect of salinity on the rate of photosynthesis was shown in mulberry trees as in many other woody trees (Kumar *et al.,* 1999). Also, growth reduction resulting in, shorter stature, respiratory changes, loss of cellular integrity, early senescence, decreased photosynthesis, tissue necrosis smaller leaves, and even death of the plant (Cheeseman, 1988). The major reason for the detrimental effects of low to moderate salt concentrations is the negative osmotic pressure caused by the salts in the root zone, the most common effects of salinity on glycophytes are loss of turgor (Jacoby, 1994). In addition, that, the salt concentrates in the old leaves resulted them die early (Munns *et al.,* 2006). Ion toxicities or nutritional deficiencies may also arise because of the predominance of a competition or specific ion among anions or cations depending upon the composition of the saline solution (Bernstein *et al.,*1974). Retardation of growth and Early senescence of older leaves followed under higher salinity because of the salt promotes senescence of leaves by increasing the production of ethylene and abscisic acid (ABA) (Kefu *et al.,* 1991 and Zhao *et al.,* 1992). In addition, Oxidative stress occurs due to impaired photosynthetic electron transport, impaired cellular membrane integrity and stomata closure under high salinity conditions. The reactive oxygen species formed during oxidative stress are able to trigger antioxidant biosynthesis as a plant defense system to decrease the risk of oxidative damage (Sairam *et al.,* 2002). Besides, the salinity stress resulted a deficit of water, causing in decreased the stomatal conductance, stomatal closure, and leaf turgor pressure, and is a limiting factor towards the photosynthesis rate. Furthermore, increasing salt concentration caused a toxicity for plants through the accumulation of the salt ion as result of osmotic and water stresses (Chaves *et al.,* 2009).

The resistance to salt of mulberry may be due to its resistant to ion toxicity, osmotic stress and water stress in addition to the associated with various physio-biochemicaltraits and morpho-anatomical.

Becides the rapid stomatal closure in case of water scarcity maintaining a higher water potential in the tissue by decreasing the transpiration operation resulting the avoiding of water stress which caused by the salinity of soil (Vijayan *et al.,* 2008a and Yan *et al.,* 2019).

Table 11: Effect of salinity doses on chemical properties of *Morus nigra* and *Morus macroura* seedlings after twelve months during 2021and 2022 seasons.

Species		Moisture percentage			Chl A mg/g			Chl B mg/g		
		Morus nigra	*Morus macroura*	Mean	*Morus nigra*	*Morus macroura*	Mean	*Morus nigra*	*Morus macroura*	Mean
					First Season 2021					
Control		53.84	51.13	52.48	1.28	1.07	1.17	1.45	1.11	1.28
3000ppm		55.41	51.73	53.57	0.88	0.71	0.79	0.97	0.96	0.96
6000ppm		52.87	48.77	50.82	0.81	0.65	0.73	0.84	0.78	0.81
Mean		54.04	50.54		0.99	0.81		1.07	0.95	
New	**A**		1.95			0.21			0.137	
L.S.D	**B**		N.S			0.13			0.031	
at 5%	**AXB**		3.79			0.39			0.275	
					Second Season 2022					
Control		52.47	51.48	51.97	1.24	1.09	1.16	1.45	1.12	1.28
3000ppm		54.37	51.94	53.15	0.87	0.74	0.80	0.76	0.97	0.86
6000ppm		52.91	47.87	50.39	0.83	0.64	0.73	0.85	0.99	0.92
Mean		53.25	50.43		0.98	0.82		1.02	1.03	
New	**A**		1.37			0.19			0.153	
L.S.D	**B**		N.S			0.11			N.S	
at 5%	**AXB**		2.67			0.35			0.213	

Table 11: Cont.

Species		Carotin mg/g			Nitrogen percentage			Proline mg/100g		
		Morus nigra	*Morus macroura*	Mean	*Morus nigra*	*Morus macroura*	Mean	*Morus nigra*	*Morus macroura*	Mean
					First Season 2021					
Control		1.38	1.05	1.21	1.20	1.25	1.22	29.50	32.06	30.78
3000ppm		0.84	0.88	0.86	1.38	1.43	1.40	33.92	39.92	36.92
6000ppm		0.84	0.82	0.83	1.43	1.87	1.65	35.41	48.34	41.87
Mean		1.02	0.92		1.33	1.52		32.94	40.11	
New	**A**		0.103			0.35			5.27	
L.S.D	**B**		0.057			0.13			3.39	
at 5%	**AXB**		0.113			0.37			7.75	
					Second Season 2022					
Control		1.39	1.11	1.25	1.21	1.33	1.27	30.50	31.50	31.00
3000ppm		0.87	0.89	0.88	1.41	1.41	1.41	34.59	36.12	35.35
6000ppm		0.84	0.90	0.87	1.47	1.70	1.58	36.06	48.91	42.48
Mean		1.03	0.97		1.36	1.48		33.72	38.84	
New	**A**		0.117			0.25			5.67	
L.S.D	**B**		0.039			0.09			2.39	
at 5%	**AXB**		0.211			0.33			7.35	

4. Conclusion

In general, we conclude from the experiment that the mulberry species *Morus nigra* was more tolerant to salinity than the other one, *Morus macroura*, as it achieved superiority in stem length, number of leaves, length and number of roots, as well as in the percentage of chlorophyll A, B, and carotene in both seasons.

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