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# Effect of Salinity and Nitrogen Sources on Growth and Chemical Composition of *Salix babylonica* Seedling

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**Abstract:** A pot experimint was carried out at the Nursery of Forestry Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt, in the two successive seasons, 2018/2019 and 2019/2020 to study the effect of three nitrogen fertilizer forms (Ammonium sulfate, ammonium nitrate and calcium nitrate) under different levels of salinity on growth and chemical composition of *Salix babylonica* seedling grown in sandy loamy soils. The results showed that, increasing salt concentration decreased seedling height, stem diameter, shoots and roots fresh and dry weights, number of branches and number of leaves concern with $9dSm^{-1}$ concentration with any nitrogen form, when compared to control. On the other hand, sugars, proline, Na and Cl increased by increasing salinity level, while chlorophyll, N, P, K and Ca were diminished. The results disclosed that using calcium nitrate as a form of nitrogen significantly increased whole of the studied growth characters compared to other sources of N fertilizers. Also, using calcium nitrate increased the contents of N, P, K and Ca, as well as chlorophyll, sugars and proline and decreased the contents of Cl and Na compared to ammonium sulfate and ammonium nitrate under the same level of salt concentration.

**Key words:** *Salix babylonica* L. · Nitrogen forms · Salinity · Proline · Sugars

## INTRODUCTION

Salinity is a major abiotic stress limiting growth and productivity of plants in many areas of the world due to increasing use of poor quality water for irrigation and soil salinization.

The salinization of soil is a major problem for agriculture and forestry that occurs in nearly all climatic regions and on all populated continents [1]. Nowadays, salinity affects 6% of the world's total land area and the world's salinized area is increasing due to intensive land use, irrigation and clearing [2, 3].

Nitrogen is a vital nutrient element essentially absorbed by plants in the form of ammonium as well as nitrate. A part from the general function of supplying nitrogen for synthesis of macromolecules such as: nucleic acids and proteins as well as amino acids and enzymes, nitrate has a specific role in regulating levels of enzymes involved in the nitrate assimilatory pathway [4].

Nitrogen fertilization plays an important role in the amelioration of salt stress. It is thought that sufficient N supply helps to compensate and correct nutritional imbalance in salt stressed plants [5].

The majority of N used by plants comes from urea, ammonium ($NH_4^+$) and nitrate ($NO_3^-$), fertilizers can be formulated to contain varying proportions of each of these forms by choosing different ingredients as reported by El-Khateeb [6] on *Eucalyptus torquata* and *E. angulosa* and Hu *et al.* [7] on wheat. It was found that the source of nitrogen can play an important role to increase plant tolerance to salinity [8-10].

However, the growth inhibition and adverse effect induced by saline stress could be alleviated by proper use of fertilizer in some trees and crops such as apple, pine, maize, cotton and oat [11-15].

Weeping willow (*Salix babylonica* L.) belongs to family Salicaceae), is a hydrophilic plant and grows along rivers, streams and in swampy areas, but also occurs on

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the mountains up to 1600 m altitude. It develops quickly and lives up to 100 years. Its wood is soft, but is used for the production of furniture, chairs, doors, cabinets, boxes, barrels and vener. It has also been used to make smaller items like toys and dolls [16].

*Salix babylonica* is a deciduous short-lived tree may reach to 20 m tall, it has d.b.h. of 60-80 cm, stem furrowed and usually divided near the ground. The flowers are a good source for honey. The young willow branches contain salicylate substance, from which the medicament aspirin is produced [17]. There is an evidence that extract of weeping willow leaves can exhibit antiparasitic action according to Hernandez *et al*. [18]. It is traditionally used as antirheumatic, antipyretic and for treatment of parasitic skin infection and ulcers. Besides its mentioned beneficial effects it's thought to have anti bacterial effect and an effect on cardiovascular system [19].

The present investigation aims to evaluate the effect of saline water and different nitrogen fertilizer forms on growth and chemical composition of *Salix babylonica* L. seedling.

## MATERIAL AND METHODS

The present investigation was conducted at the Nursery of Forestry Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt, during two successive seasons of 2018/2019 and 2019/2020. Soil sample from the experimental used soil was collected and analyzed for some physical and chemical properties (Table 1) according to Page *et al*. [20].

One year old seedlings of *Salix babylonica* purchased from a private farm at EI-Qanater El-Khayria, Qalioubia Governorate, 20-km northwest of Cairo. The seedlings were planted on the last week of Febraury in both seasons in plastic pots of 30 cm height and 25 cm diameter, filled with 12 kg of soil mixture involving sand and loamy soils at a ratio 2:1 (v/v) respectively . Seedlings were uniform and healthy as possible. They were chosen, with an average height 30-35cm. and average stem diameter at base of 0.3cm, soil mixture was subjected to four salinity levels beside control (tap water).

**Salts Used:** Three sorts of salts were used by adding a mixture of sodium chloride, calcium chloride and magnesium sulphate by a ratio of 2: 2: 1, respectively.

**Preparation of the Salt Solution:** A stock solution with concentration of (100 dS $m^{-1}$) was prepared as follows: 25.6 g of NaCl, 25.6 g of $CaCl_2$ and 12.8 g of $MgSO_4$ and these salts were dissolved in one liter of tap water to prepare the operative solution. Then the following volumes were used to prepare the desired solutions in Table (2).

So, we got the solutions concentrations of (3, 5, 7 and 9dS $m^{-1}$), beside control (Tap water).

Each pot contained one seedling. Seedlings were grown under four salinity irrigation regimes (in both seasons) i.e:

The treatments consist of :

- The untreated plants( control ) were irrigated with tap water.
- The seedlings were received nitrogen at 1g N-element/pot from the three forms as follows.

- Ammonium sulphate $(NH_4)_2$ $SO_4$(20.5 %) N(4.9 g /pot)
- Ammonium nitrate $NH_4NO_3$ (33.5% N) (3.0g /pot)
- Calcium nitrate Ca $(NO_3)_2$ (15.5 %N) (6.5g /pot)

After a month from planting of the seedlings, the N- fertilizers were applied separately every month until the end of the experiment in the first of Febraury of the following year. The irrigation with salt solution in different concentrations in addition to control treatment was done twice weekly in winter and three times in summer, the volume of water added to plants was (3.450l/pot) according to 100% field capacity determined in this soils. The pots were irrigated with tap water each month to avoid salt accumulation in the root zone.

The following data were recorded each season:
Growth parameters:

- Seedling height ( cm)
- Stem diameter (cm)
- Leaves and branches number /plant
- Fresh and dry weights of shoots and roots/ plant (g)

**Chemical Determination:** The plant samples(shoots and roots) were dried in an oven at 70°C and digested by using $H_2SO_4$ and $HClO_4$ mixture according to methods described by Chapman and Pratt [21] and the following nutrients concentration were determined.

- Nitrogen concentration was determined by Nessler method according to A.O.A.C. [22].
- Phosphorus concentration was estimated colorimetrically by using the chlorostannous reduced molybdophosphoric blue colour method as described by King [23].

Table 1: Physical and chemical analysis of the used soil

| Sand (%) | | Silt (%) | | | | Clay (%) | | | | | Texture class |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.0 | | 7.8 | | | | 5.2 | | | | | Sandy loamy |
| | | Soluble cations (meq/l) | | | | | | Soluble anions (meq/l) | | | |
| pH 1:2.5 | E.C ($dSm^{-1}$) | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | N (ppm) | P (ppm) | $CO_3^-$ | $HCO_3^-$ | $Cl^-$ | $SO_4^-$ |
| 7.40 | 0.87 | 2.20 | 1 .45 | 1.73 | 2.96 | 20 | 6 | - | 1.43 | 3.4 0 | 2.49 |

Table 2: Preparation of the salt solution

| Concentration ($dSm^{-1}$) | Volume from stock (ml) | Final volume (ml) |
|---|---|---|
| 3 ($dSm^{-1}$) | 30 ml | 1000 ml |
| 5 ($dSm^{-1}$) | 50 ml | 1000 ml |
| 7 ($dSm^{-1}$) | 70 ml | 1000 ml |
| 9 ($dSm^{-1}$) | 90 ml | 1000 ml |

(1 $dSm^{-1}$) = 640ppm

- Potassium and sodium concentrations were determined by using the flame photometric method according to Piper [24].
- Chloride concentration was determined by titration method with silver nitrate according to Brown and Jackson [25].
- Calcium concentration was determined by titration with ethylene di-amine tetra acetate (versentate) according to Richards *et al*. [26].
- Total chlorophylls in fresh leaves were extracted with dimethyl formamid solution described by Mornai [27].
- Total sugar were determined in the ethanolic extract of fresh shoots by using phenol-sulphuric acid reagent according to Dubois *et al*. [28].
- Free proline concentration was measured calorimetrically in extraction of fresh leaves using ninhydin reagent according to Bates *et al.* [29].

**Statistical Analysis:** The layout of the experiment was a completely randomized block design in factorial arrangement, as the main treatment was salinity levels and subtreatment was N source. The studied factors were analyzed statistically by using.Duncan [30] multiple range test 5% and according to Steel and Torrie [31].

## RESULTS AND DISCUSSION

**The Effect of Salinity Stress and Nitrogen Forms on Growth Parameters:** Concerning the effect of salinity, data in Tables (3, 4, 5 and 6) revealed that, in the two successive seasons, significant and gradual decreases in all of the studied growth parameters (seedling height, stem diameter, fresh and dry weights of shoots and roots, as well as number of branches and leaves/plant) were recorded by increasing salinity levels up to (9dS $m^{-1}$) compared to control which recorded the highest values for the previous parameters. The mentioned data showed a relative increase with decreasing soil salinity (3 $dSm^{-1}$) and recorded 72.00(cm), 0.57(cm), 59.87(g), 25.32(g), 15.40(g), 6.62(g), 4.14/plant and 182.70 /plant, respectively in the first season and the corresponding values in the second season were 80.5(cm), 0.75(cm), 77.30(g), 27.89(g), 19.94(g), 8.98(g), 4.29/plant and 233.70/plant.

It is worthy to mention that noticeable increases in all growth parameters were achieved as the salinity level decreased.

The reduction in seedling height might be due to salinity which decreased the cell division, cell elongation and meristemic activity. Ruf *et al.* [32] who also, mentioned under salinity condition the reduction of leaves number/plant might cause a disturbance in natural hormones leading to unbalanced growth of the plant . Moreover, the decrease in fresh and dry weights of shoots and roots due to the more Cl or Na accumulation in leaves might cause injury by interfering with normal stomatal closure causing excessive water loss and leaf injury symptoms. Also, such decrease in fresh and dry weights of shoots might be due to the inhibition of water absorption and/ or distribution of mineral balance and utilization under salinity condition [33].

On the other hand, data in Tables (3, 4, 5 and 6) revealed that, in the two successive seasons the application of calcium nitrate as a source of N had favorable effects on all of the studied growth characters (seedling height, stem diameter, fresh and dry weights of shoots and roots, as well as number of branches and leaves) were 135.5(cm), 1.2(cm), 219.0(g), 76.7(g), 55.1(|g), 26.5(g), 8.08/plant and 360.0/plant respectively, in the first season, whereas the corresponding values of the second season were 162.5(cm), 1.44(cm), 192.0(g), 65.33(g), 47.93(g), 24.05(g), 6.81/plant and 268.70/plant.

Table 3: Effect of nitrogen form on seedling height and stem dimeter (cm) of *Salix babylonica* under different levels of salinity during the seasons 2018/2019 and 2019/2020

| Character | Seedling height (cm) | | | | | Stem diameter (cm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | |
| Salinity ($dsm^{-1}$) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| | | | | | First season (2018/2019) | | | | | |
| Control | 75.00k | 81.67i | 94.83f | 135.5a | 96.88A | 0.63h | 0.76e | 0.89c | 1.20a | 0.87A |
| 3. | 72.00l | 75.50k | 90.67g | 130.3b | 92.12B | 0.57j | 0.65g | 0.74f | 1.07b | 0.76B |
| 5. | 65.33m | 71.83l | 87.33h | 125.5c | 87.50C | 0.52k | 0.61i | 0.67g | 0.86d | 0.67C |
| 7. | 60.50n | 65.83m | 80.83j | 119.0d | 81.54D | 0.43l | 0.52k | 0.61i | 0.67g | 0.56D |
| 9. | 53.50o | 60.67n | 75.67k | 113.8e | 75.91E | 0.41m | 0.42lm | 0.51k | 0.56j | 0.48E |
| **Mean | 65.37D | 71.10C | 85.87B | 124.8A | | 0.51D | 0.59C | 0.68B | 0.87A | |
| | | | | | Second season (2019/2020) | | | | | |
| Control | 85.17l | 120.5f | 136.3d | 162.5a | 126.1A | 0.88h | 0.95f | 1.25b | 1.44a | 1.13A |
| 3. | 80.50o | 115.7h | 125.3e | 155.2b | 119.2B | 0.75kl | 0.85i | 1.11d | 1.21c | 0.98B |
| 5. | 76.67p | 103.3i | 119.5g | 144.0c | 110.9C | 0.68m | 0.81j | 0.89gh | 1.03e | 0.85C |
| 7. | 69.67p | 82.67h | 95.83k | 120.8f | 92.24D | 0.64n | 0.76k | 0.84i | 0.91g | 0.79D |
| 9. | 60.50s | 75.67n | 84.00m | 97.17j | 79.34E | 0.56o | 0.63n | 0.69m | 0.73l | 0.65E |
| **Mean | 74.5D | 99.57C | 112.2B | 135.9A | | 0.70D | 0.80C | 0.96B | 1.06A | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Table 4: Effect of nitrogen form on fresh and dry weights of shoots (g) of *Salix babylonica* under different levels of salinity during the seasons 2018/2019 and 2019/2020

| Character | Fresh weight of shoots (g.) | | | | | Dry weight of shoots (g.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | |
| Salinity ($dsm^{-1}$) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| | | | | | First season (2018/2019) | | | | | |
| Control | 121.3d | 163.7c | 174.7b | 219.0a | 169.7A | 39.80d | 59.73c | 62.23b | 76.70a | 59.62A |
| 3. | 59.87i | 68.20g | 79.33f | 108.7e | 79.03B | 25.32hi | 26.90gh | 31.97f | 36.67e | 30.22B |
| 5. | 42.93l | 51.67k | 56.93j | 79.13f | 57.67C | 12.03n | 22.63jk | 23.90ij | 28.40g | 21.74C |
| 7. | 34.25n | 39.17m | 51.15k | 63.08h | 46.91D | 7.35o | 18.07l | 21.30k | 25.03hi | 17.94D |
| 9. | 20.27p | 31.50o | 34.77n | 43.08l | 32.40E | 4.59p | 14.20m | 15.57m | 18.30l | 13.17E |
| **Mean | 55.72D | 70.85C | 79.38B | 102.6A | | 17.82D | 28.31C | 30.99B | 37.02A | |
| | | | | | Second season (2019/2020) | | | | | |
| Control | 152.0e | 163.0d | 187.6b | 192.0a | 173.7A | 52.57e | 56.90d | 64.03b | 65.33a | 59.71A |
| 3. | 77.30l | 97.00i | 139.0f | 178.7c | 123.0B | 27.89k | 36.40h | 47.23f | 60.37c | 42.97B |
| 5. | 50.27n | 89.13j | 127.8g | 164.9d | 108.0C | 18.90l | 32.27i | 44.33g | 52.40e | 36.98C |
| 7. | 41.33o | 83.33k | 108.0h | 137.1f | 92.43D | 15.23m | 30.37j | 37.20h | 43.23g | 31.51D |
| 9. | 22.27p | 53.33m | 78.00l | 106.1h | 64.93E | 9.77n | 19.33l | 27.77k | 33.20i | 22.52E |
| **Mean | 68.63D | 97.16C | 128.1B | 155.8A | | 24.87D | 35.05C | 44.11B | 50.91A | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Table 5: Effect of nitrogen form on fresh and dry weights of roots(g) of *Salix babylonica* under different levels of salinity during the seasons 2018/2019 and 2019/2020

| Character | Fresh weight of roots (g.) | | | | | Dry weight of roots (g.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | |
| Salinity ($dsm^{-1}$) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| | | | | | First season (2018/2019) | | | | | |
| Control | 30.83d | 41.63c | 44.27b | 55.10a | 42.96A | 13.45d | 19.00c | 21.37b | 26.50a | 20.08A |
| 3. | 15.40i | 17.13g | 20.07f | 25.20e | 19.45B | 6.62i | 7.80h | 9.07g | 12.62e | 9.03B |
| 5. | 11.33k | 13.37j | 14.93i | 20.54f | 15.04C | 3.62m | 5.77j | 6.80i | 10.33f | 6.63C |
| 7. | 8.50n | 9.81m | 13.30j | 16.20h | 11.95D | 2.28o | 4.03l | 5.87j | 6.90i | 4.77D |
| 9. | 5.28o | 8.04n | 9.27m | 10.59l | 8.30E | 0.59p | 3.00n | 3.90l | 4.53k | 3.01E |
| **Mean | 14.27D | 18.00C | 20.37B | 25.53A | | 5.31D | 7.92C | 9.40B | 12.18A | |
| | | | | | Second season (2019/2020) | | | | | |
| Control | 37.90f | 41.00e | 47.33c | 47.93b | 43.54A | 18.02f | 19.45e | 22.27c | 24.05a | 20.95A |
| 3. | 19.94m | 25.00j | 34.00g | 49.17a | 32.03B | 8.98n | 11.60k | 16.27g | 23.57b | 15.11B |
| 5. | 12.73o | 22.10k | 32.00h | 41.72d | 27.14C | 5.53p | 10.70l | 15.01i | 19.85d | 12.77C |
| 7. | 10.51p | 21.20l | 27.27i | 34.40g | 23.35D | 4.15q | 9.83m | 13.87j | 15.92h | 10.94D |
| 9. | 5.55q | 13.90n | 20.18m | 24.93j | 16.14E | 1.98r | 6.01o | 9.88m | 14.83i | 8.18E |
| **Mean | 17.33D | 24.64C | 32.16B | 39.63A | | 7.73D | 11.52C | 15.46B | 19.64A | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Table 6: Effect of nitrogen form on number of branches and number of leaves / plant of *Salix babylonica* under different levels of salinity during the seasons 2018/2019 and 2019/2020

| Character | No. of branches/plant | | | | | No. of leaves/plant | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | |
| Salinity (dsm$^{-1}$) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| | | | | | First season (2018/2019) | | | | | |
| Control | 4.59i | 6.14e | 6.54d | 8.08a | 6.34A | 203.7i | 274.0e | 294.0d | 360.0a | 282.9A |
| 3. | 4.14k | 4.55i | 5.31g | 7.17b | 5.29B | 182.7k | 205.0i | 240.7g | 319.0b | 236.9B |
| 5. | 3.52l | 4.27j | 4.84h | 6.74c | 4.84C | 163.7l | 195.0j | 219.7h | 305.3c | 220.9C |
| 7. | 3.07m | 3.43l | 4.52i | 5.52f | 4.14D | 136.0o | 156.3m | 205.0i | 251.0f | 187.1D |
| 9. | 2.17n | 3.15m | 3.45l | 4.29j | 3.27E | 92.67p | 144.7n | 154.0m | 197.7j | 147.3E |
| **Mean | 3.50D | 4.31C | 4.93B | 6.36A | | 155.8D | 195.0C | 222.7B | 286.6A | |
| | | | | | Second season (2019/2020) | | | | | |
| Control | 4.65h | 5.14f | 5.64d | 6.81a | 5.56A | 252.3g | 266.3f | 310.7c | 268.7a | 299.5A |
| 3. | 4.29j | 4.47i | 5.60d | 6.29b | 5.16B | 233.7i | 240.3h | 295.0d | 338.7b | 276.9B |
| 5. | 3.66m | 4.14k | 5.23e | 5.81c | 4.71C | 191.7l | 208.7j | 278.7e | 315.4c | 248.6C |
| 7. | 3.41n | 3.82l | 4.33j | 4.72g | 4.07D | 184.7m | 200.1k | 235.7hi | 254.8g | 218.8D |
| 9. | 1.85q | 2.42k | 3.18o | 3.65m | 2.78E | 98.13p | 120.0o | 174.0n | 203.0k | 148.8E |
| **Mean | 3.57D | 4.00C | 4.80B | 5.46A | | 192.1D | 207.1C | 258.8B | 296.1A | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).

*Main treatment (salinity levels) **Sub treatment (N. form)

N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Regarding the effect of the combination between N-sources and salinity stress on vegetative growth of *Salix babylonica*, the data indicated that all combinations between different sources of nitrogen fertilizers and the lowest level of saline irrigation (3 dSm$^{-1}$) enchanced most of vegetative growth traits in the two seasons and it was notably by using calcium nitrate with the low level of salinity (3 dSm$^{-1}$). The obtained data in the first season were 130.3(cm), 1.07(cm), 108.7(g), 36.67(g), 25.20(g), 12.62(g), 7.17/plant and 319.0/plant) for the following growth parameters (seedling height, stem diameter, fresh and dry weights of shoots and roots, as well as number of branches and leaves), respectively, while in the second season the values of these parameters were155.20(cm), 1.21(cm),178.70(g),60.37(g)|,49.17(g),23.57(g),6.29/plant and 338.70/plant ) respectively. These results were in harmony with Naidoo [34] on mangrove plants, who showed that using any nitrogen source combined with salts at the lowest concentration was more effective in reducing the harmfulness of saline effect than at the highest concentration of salts.

External salinization affects N metabolism, mainly ion uptakes, N assimilation, amino acid and protein synthesis [35]. Moreover, reduction of nitrate or ammonium uptake after NaCl treatment has been observed in several plant species [36]. However, it was noticed that calcium nitrate treatment was more effective than others forms of nitrogen fertilization, this may be due to high mobility of $NO_3^-$N which easily leaches out. Thus, it is more available in the soil for the plant to take it up again [37]. Nitrate is often a preferential source for plant growth. Plant mainly takes up $NO_3$ even when $NH_4$ fertilizers are applied, due to the microbial oxidation of the $NH_4$ in the soil. Moreover, nitrate is the only inorganic form that can accumulate in the plant tissues without injurious effect. Generally, increase in fresh and dry weights of shoots may be explained on the assumption that, with increasing N supply the proportion of the carbohydrate used in the aerial portions increases [8].

**The Effect of Salinity Stress and Nitrogen Forms on Chemical Composition:** Data in Table (7) showed that, salinity stress caused a depressive effect on total chlorophylls giving the lowest value (0.44mg/g F.W) in the first season and (0.46mg/g F.W) in the second one, under the highest salinity level (9dSm$^{-1}$)compared to control, which recorded the highest value (0.82 mg/g F.W) followed by (0.74 mg/g F.W) at salinity level (3 dSm$^{-1}$ ) in the 1st and (0.70 mg/g F.W) followed by (0.66 mg/g F.W) at the same level in the 2nd season.

As regard the effect of nitrogen sources, it was found that calcium nitrate gave the highest value of (0.96 mg/g F.W)and (0.91 mg/g F.W) in the 1st and 2nd seasons, respectively compared to the other forms of N. The interactions between salinity levels and different forms of N for both seasons (Table 7) revealed that growing *Salix babylonica* under salinity level of (3 dSm$^{-1}$) and fertlized with calcium nitrate recorded the

Table 7: Effect of nitrogen form on total chlorophyll, total sugars and proline (mg/gF.w) of *Salix babylonica* under different levels of salinity during the seasons 2018/2029 and 2019/2020

| Character | Total chlorophyll (mg/g F.w) | | | | | Total sugars (mg/gF.w) | | | | | Proline (mg/gF.w) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | | | | | | |
| Salinity (dsm$^{-1}$) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | Mean | Control | N1 | N2 | N3 | *Mean |
| | | | | | | First season (2018/2019) | | | | | | | | | |
| Control | 0.82f | 0.85e | 0.90c | 0.96a | 0.88A | 3.20l | 4.30j | 4.35j | 4.80i | 4.16 E | 0.17j | 0.19i | 0.21h | 0.28e | 0.21E |
| 3. | 0.74i | 0.80g | 0.87d | 0.92b | 0.83B | 3.60k | 4.90hi | 5.20ef | 5.80c | 4.88D | 0.19i | 0.25f | 0.27e | 0.30d | 0.25D |
| 5. | 0.69j | 0.74i | 0.79g | 0.84e | 0.77C | 4.30j | 5.10fg | 5.90c | 6.07b | 5.35B | 0.20hi | 0.27e | 0.30d | 0.33c | 0.28C |
| 7. | 0.63k | 0.70j | 0.73i | 0.77h | 0.71D | 5.00gh | 5.30e | 6.10b | 6.15ab | 5.64B | 0.23g | 0.30d | 0.31d | 0.35b | 0.30B |
| 9. | 0.44n | 0.47m | 0.57i | 0.62k | 0.53E | 5.60d | 5.80c | 6.20Ab | 6.25a | 5.96A | .0.27E | 0.31d. | 0.34bc. | 0.38A | 0.33a |
| **Mean | 0.66D | 0.71C | 0.77B. | 0.82A. | | | 4.34D | 5.08C | 5.55B | 5.81A | | 0.21D | 0.29C | 0.29B | 0.33A. |
| | Second season (2019/2020) | | | | | | | | | | | | | | |
| Control | 0.70f | 0.76d | 0.82b | 0.91a | 0.80A | 4.62l | 4.71k | 4.75k | 5.15i | 4.81E | 0.24ij | 0.22kl | 0.20m | 0.18n | 0.21D |
| 3. | 0.66g | 0.70f | 0.71f | 0.82b | 0.72B | 5.00j | 5.30h | 5.65f | 5.94d | 5.47D | 0.31de | 0.27h | 0.25i | 0.21lm | 0.26C |
| 5. | 0.62i | 0.67g | 0.73e | 0.79c | 0.70C | 5.35h | 5.7f | 5.92d | 6.15c | 5.78C | 0.36c | 0.32d | 0.29fg | 0.23jk | 0.30B |
| 7. | 0.51k | 0.58j | 0.64h | 0.62i | 0.59D | 5.52g | 5.69f | 6.12c | 6.35b | 5.92B | 0.40b | 0.35c | 0.30ef | 0.27h | 0.33A |
| 9. | 0.46l | 0.52k | 0.51k | 0.62i | 0.53E | 5.69f | 5.81e | 6.32b | 6.60a | 6.11A | 0.43a | 0.39b | 0.28gh | 0.25i | 0.34A |
| **Mean | 0.59D | 0.65C | 0.68B | 0.75A | | | 5.24D | 5.44C | 5.75B | 6.04A | | 0.35A | 0.31B | 0.26C | 0.23D |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).

*Main treatment (salinity levels) **Sub treatment (N. form)

N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

highest values for total chlorophylls (0.92 and 0.82 mg/g F.W) in the1$^{st}$ and 2$^{nd}$ seasons, respectively. The obtained results might be ascribed to the depressive effect of salinity stress that led to a depression in the biosynthesis of chlorophylls through inhibiting the absorption of some ions which are essential and involved in the chloroplast formation as Mg and Fe [38]. Also, we noticed that concentration of total chlorophyll reduced after salt treatment and this reduction was much more affected by salt treatment in $NH_4$ fed plants compared to the $NO_3$ fed plants. These results indicate that salix plant performs better under salt stress when fed with $NO_3$. Meng *et al.* [39] suspected that this effect might have two potential explanations, as salt stress causes a direct reduction of $NH^+_4$ uptake in the roots in response to the salt stress; and salt stress causes a reduction of $NH_4$ production form. These results are in agreement with Batanouny *et al.* [40].

Moreover, data represented in Table (7) demonstrated that there is a progressive effect on the contents of total sugars and proline which significantly increased by increasing salinity levels giving 5.60 and 5.69 mg/g F.W for total sugars and 0.27 and 0.25 mg/gF.W for proline when were grown at salinity level (9dsm$^{-1}$) in the 1$^{st}$ and 2$^{nd}$ seasons, respectively and calcium nitrate was the best form of N fertilizer for increasing total sugars and proline contents in both seasons.

Furthermore, the interaction effect between salinity levels and different forms of N (Table 7) revealed that growing plants under salinity level at (9dSm$^{-1}$) and fertilized with calcium nitrate recorded the highest values of total sugars (6.25 and 6.60 mg/g F.W) in the 1$^{st}$ and 2$^{nd}$ seasons, respectively and it gave the highest values for proline (0.38 and 0.43 mg/gF.W) in the1$^{st}$ and 2$^{nd}$ seasons, respectively. These results may be explained by that, when cells exposed to osmotic stress tend to redirect carbon flow to osmoregulation (osmotic adjustment) by accumulation of a variety of common solutes, including sugars, amino acids, organic acids, proline and other metabolically protective osmolities leading to water retention. Similar results were obtained by Hanafy Ahmed *et al.* [41] reported that the accumulation of non toxic substances such as sucrose and proline are considered to be a protective adaptation and for the survival of plants under salinity stress. Also, proline accumulated during stress conditions serves as an important energy source for use during plant recovery [42-43].

Woody plants are known to synthesize and accumulate compatible organic solutes such as glycine betaine, proline and soluble carbohydrates in the cytoplasm to regulate osmotic potential [44]. Similar results indicated that, proline content in leaves of *Salix viminali* was found to be an excellent indicator of salt tolerance among different varieties [45].

Concerning the effect of salinity and N-sources treatments on the concentration of N, P and K of shoots and roots, the results presented in Tables (8, 9 and 10) indicated that N, P and K concentrations decreased with increasing salinity level (9dSm$^{-1}$), in the two seasons.

Table 8: Effect of nitrogen form on N% of shoots and roots of *Salix babylonica* under different levels of salinity during the seasons 2018/2029 and 2019/2020

| Character | N % shoots | | | | | N % roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | |
| Salinity (dsm⁻¹) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| First season (2018/2019\|) | | | | | | | | | | |
| Control | 2.95d | 3.14b | 3.06c | 3.72a | 3.22A | 1.62bc | 1.66b | 1.72a | 1.74a | 1.69A |
| 3. | 2.80f | 2.92de | 2.89e | 2.92de | 2.88B | 1.55de | 1.58cd | 1.63bc | 1.61bc | 1.59B |
| 5. | 2.34i | 2.71g | 2.71g | 2.81f | 2.64C | 1.33h | 1.51ef | 1.51ef | 1.52ef | 1.47C |
| 7. | 2.04k | 2.55i | 2.56i | 2.62h | 2.44D | 1.13j | 1.43g | 1.46fg | 1.47fg | 1.37D |
| 9. | 1.55l | 2.35j | 2.32j | 2.51i | 2.18E | 1.02k | 1.22i | 1.32h | 1.33h | 1.22E |
| **Mean | 2.34C | 2.73B | 2.71B | 2.92A | | 1.33C | 1.48B | 1.53A | 1.53A | |
| Second season (2019/2020) | | | | | | | | | | |
| Control | 2.54d | 2.70c | 2.2b | 3.03a | 2.77A | 1.42f | 1.54c | 1.56b | 1.63a | 1.54A |
| 3. | 2.40e | 2.53d | 2.69c | 2.79b | 2.60B | 1.28j | 1.37g | 1.44e | 1.51d | 1.40B |
| 5. | 2.25g | 2.31f | 2.52d | 2.71c | 2.45C | 1.23k | 1.28ij | 1.35h | 1.43ef | 1.32C |
| 7. | 2.13h | 2.23g | 2.33f | 2.56d | 2.31D | 1.16m | 1.22kl | 1.29ij | 1.38g | 1.26D |
| 9. | 1.5j | 2.07i | 2.16h | 2.24g | 2.08E | 0.97n | 1.15m | 1.21l | 1.30i | 1.16E |
| **Mean | 2.23D | 2.37C | 2.50B | 2.67A | | 1.21D | 1.31C | 1.37B | 1.45A | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Table 9: Effect of nitrogen form on P% of shoots and roots of *Salix babylonica* under different levels of salinity during the seasons 2018/2029 and 2019/2020

| Character | P % shoots | | | | | P % roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | |
| Salinity (dsm⁻¹) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| First season (2018/2109) | | | | | | | | | | |
| Control | 0.89e | 1.13c | 1.22b | 1.46a | 1.18A | 0.45g | 0.56d | 0.60c | 0.73a | 0.59A |
| 3. | 0.76f | 0.98d | 1.10c | 1.27b | 1.03B | 0.39h | 0.49e | 0.55d | 0.64b | 0.52B |
| 5. | 0.65h | 0.88e | 0.89e | 0.98d | 0.85C | 0.2j | 0.44g | 0.44g | 0.48f | 0.42C |
| 7. | 0.55i | 0.74fg | 0.76f | 0.77f | 0.71D | 0.28k | 0.37h | 0.38h | 0.39h | 0.36D |
| 9. | 0.47j | 0.64h | 0.69gh | 0.71fg | 0.63E | 0.24l | 0.33j | 0.34j | 0.36i | 0.32E |
| **Mean | 0.66D | 0.87C | 0.93B | 1.04A | | 0.34D | 0.44C | 0.46B | 0.52A | |
| Second season (2019/2020) | | | | | | | | | | |
| Control | 0.93de | 1.11c | 1.26b | 1.36a | 1.17A | 0.46f | 0.56d | 0.64b | 0.68a | 0.59A |
| 3. | 0.84f | 0.98d | 1.10c | 1.30b | 1.06B | 0.42h | 0.50e | 0.55d | 0.62c | 0.52B |
| 5. | 0.77g | 0.93de | 0.98d | 1.12c | 0.95C | 0.39i | 0.47f | 0.50e | 0.55d | 0.48C |
| 7. | 0.74g | 0.84f | 0.87ef | 0.96d | 0.85D | 0.37i | 0.42h | 0.44g | 0.49e | 0.43D |
| 9. | 0.64h | 0.76g | 0.76g | 0.83f | 0.75E | 0.32j | 0.38i | 0.39i | 0.41h | 0.38E |
| **Mean | 0.78D | 0.92C | 0.99B | 1.11A | | 0.39D | 0.47C | 0.50B | 0.55B | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Table 10: Effect of nitrogen form on K% of shoots and roots of *Salix babylonica* under different levels of salinity during the seasons 2018/2029 and 2019/2020

| Character | K % shoots | | | | | K % roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen form | | | | | | | | | | |
| Salinity (dsm⁻¹) | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| First season (2019/2020) | | | | | | | | | | |
| Control | 2.14ef | 2.23cd | 2.29ab | 2.31a | 2.24A | 1.09a | 1.15a | 1.16a | 1.17a | 1.14A |
| 3. | 1.99g | 2.13ef | 2.18de | 2.24bc | 2.14B | 0.58g-i | 0.98b | 1.11a | 1.13a | 0.95B |
| 5. | 1.50k | 1.80i | 1.89h | 2.09f | 1.82C | 0.69e-g | 0.84cd | 0.87c | 1.07ab | 0.87C |
| 7. | 1.13m | 1.63j | 1.79i | 1.91h | 1.62D | 0.51i | 0.63f-h | 0.72ef | 0.75de | 0.65D |
| 9. | 0.85n | 1.39l | 1.52k | 1.8j | 1.36E | 0.36j | 0.50i | 0.52hi | 0.53hi | 0.48E |
| **Mean | | 1.84C | 1.93B | 2.05A | | 0.65D | 0.82C | 0.88B | 0.93A | |
| Second season (2019/2020) | | | | | | | | | | |
| Control | 1.72f | 1.91cd | 2.01b | 2.16a | 1.95A | 0.60f | 0.78c | 0.86b | 0.95a | 0.80A |
| 3. | 1.67f | 1.82e | 1.92cd | 1.96bc | 1.84B | 0.55g | 0.68e | 0.75d | 0.86b | 0.71B |
| 5. | 1.42gi | 1.51g | 1.67f | 1.86de | 1.62C | 0.33k | 0.41h | 0.67e | 0.76d | 0.54C |
| 7. | 1.32j | 1.41i | 1.48gh | 1.81e | 1.51D | 0.31l | 0.37i | 0.40h | 0.74d | 0.46D |
| 9. | 1.12l | 1.20k | 1.28j | 1.50g | 1.28E | 0.29m | 0.31l | 0.36j | 0.42h | 0.35E |
| **Mean | 1.45D | 1.57C | 1.67B | 1.86A | | 0.42D | 0.51C | 0.61B | 0.72A | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

In addition, increasing N, P and K concentrations was observed with calcium nitrate application and it was the best source of N fertilizers compared to other forms. As well as, the lowest level of salinity ($3dSm^{-1}$) in combined with calcium nitrate as a source of N fertilizer achieved the highest values of N, P and K concentrations recording 2.92 and 1.61 % for( N ) in shoots and roots in 1st season and 2.79 and 1.51 % in 2nd season. Also, for (P) concentration, the values were 1.27 and 0.64% and 1.3 and 0.62% in shoots and roots in the 1st and 2nd seasons respectively, while, for (K) the data gave 2.24 and 1.13 % and 1.96 and 0.86 % in shoots and roots in the 1st and 2nd seasons, respectively. The data revealed that the increase of N, P and K caused by an increase of root exchange capacity resulting from N application and more uptake of bivalent cations [46]. The better results were obtained with $NO^{-}_{3}N$ fed plants. In addition, the obtained results revealed that salinity decreased Kconcentration which may occur through Ca and Na antagonistic effect on K uptake, as mentioned by Greenway and Munns [47]. The decrease could be caused by the antagonism of Na and K uptake sites of roots and to the effect of sodium on K transport into xylems or to the inhibition uptake processes [48]. Also, increasing N% due to nitrogen fertilizers was in accordance with Wei *et al.* [49] who mentioned that all fertilizers types application increased N storage of the plants.

In the case of P concenteration it is probably that the reduction of P availability in saline soil may be due to changes in ionic balance and the control of phosphate concentration in soil solution by low Ca-P dissolution.

Concerning the effect of different treatments on concentration of Na and Cl in shoots and roots of *Salix babylonica*, data presented in Tables (11 and 12) indicated that significant increases in (Na mg/g D.W.) and (Cl mg/g D.W.) were recorded with increasing salinity levels ($9dSm^{-1}$) and ammonium sulphate gave the highest concentration of both elements in the first and second seasons compared to other sources of N fertilizers. Also, data revealed that Na and Cl concentrations were decreased by using nitrogen fertilization compared to non fertilized control. This decrease might be related to antagonistic effect between chloride, nitrate, sodium and ammonium on their uptake. The uptake of nitrate is known to compete with that of $Cl^{-}$, a major ion in saline soil [50].

With regard to the interaction effect between salinity levels and the different forms of N, the data revealed that the high applied rate ($9dSm^{-1}$) of salinity with ammonium sulphate fertilizer exhibited higher values of Na and Cl concentration and recorded (3.15, 1.60 mg/g D.W.) and (3.51, 1.75 mg/g D.W.) for (Na) in shoots and roots in the 1st and 2nd seasons, respectively, while for (Cl) concentration the values recorded were (2.14, 1.92 mg/g D.W.) and (2.40, 1.16 mg/g D.W.) in shoots and roots in the 1st and 2nd seasons, respectively.

Moreover, data presented in Table (13) showed that the concentration of calcium increased by increasing level of salinity and calcium nitrate gave the highest concentration of $Ca^{++}$ compared to other forms of N. The combined treatment between salinity level ($9dSm^{-1}$) and calcium nitrate fertilizer recorded the highest values of Ca concentration (2.45, 0.81%) in shoots and (2.34, 0.79%) in roots in the 1st and 2nd seasons, respectively. It is clear from the obtained results that the accumulation of Na may be a result of decreased uptake of K and Ca [51]. The high uptake of Ca may be attributed to the soil salinity treatment in which of CaCl and NaCl were used. Thus the substitution of K/Ca by Na may lead to nutritional imbalances [52].

Some other studies indicated that increased nitrate in nutrient solution could decrease chloride uptake and its accumulation [53]. Also, Fisarakis *et al.* [54] found that $NO^{-}_{3}$ N was significantly reduced in salt stressed sultana vines and this reduction was correlated with photosynthesis reduction .Morover, Krisztina *et al.* [55] showed that $NH_4$ fed wheat, maize and sunflower were more sensitive to salinity than $NO_3$ fed plants and biomass production of ammonium fed plants was lower than of nitrate fed plants. Also, they mentioned that the protection of plant against salt stress by an exogenous supply of N is believed to be caused directly as a result of its' effect on K uptake which plays an essential role in many metabolic processes such as: photosynthesis process and hence the formation of starch.

It is evident that the destructive effect of salinity on plant growth is partly related to the reduction of the essential nutrients elements lower than optimal level in plant tissues. In fact it can be concluded that the effect of N on the improvement of plant growth is partly due to it's effect on reducing $Cl^{-}$ absorption and preventing the transition of this element from roots to shoots. Furthermore, N alleviated the harmful effect of salinity on reduction of plant essential nutrients by increasing their concentrations in shoot tissue. So, it can be stated that the adverse effect is to some extent linked with ion balance and maintaining of essential nutrient concentration in plant under saline conditions. Hence it could be recommended that plants grown in regions irrigated with saline water need nitrogen fertilizers form

Table 11: Effect of nitrogen form on (Na mg/g D.W.) of shoots and roots of *Salix babylonica* under different levels of salinity during the seasons 2018/2029 and 2019/2020

| Character / Nitrogen form / Salinity ($dsm^{-1}$) | (Na mg/g D.W.) shoots | | | | | (Na mg/g D.W.) roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| First season (2018/2019) | | | | | | | | | | |
| Control | 0.40k | 0.32l | 0.24m | 0.20mn | 0.29E | 0.19jk | 0.18j-l | 0.14kl | 0.12l | 0.16E |
| 3. | 0.89i | 0.78j | 0.74j | 0.16n | 0.64D | 0.36i | 0.40i | 0.36i | 0.24j | 0.34D |
| 5. | 1.68f | 1.59g | 1.57g | 1.14h | 1.50C | 0.76f | 0.73f | 0.65g | 0.56h | 0.68C |
| 7. | 2.38d | 2.31d | 2.20e | 2.13e | 2.26B | 1.19c | 1.11d | 0.93e | 0.67g | 0.98B |
| 9. | 3.29a | 3.15b | 3.02c | 2.16e | 2.91A | 1.75a | 1.60b | 1.08d | 0.78f | 1.30A |
| **Mean | 1.73A | 1.63B | 1.55C | 1.16D | | 0.85A | 0.80B | 0.63C | 0.47D | |
| Second season (2019/2020) | | | | | | | | | | |
| Control | 0.44n | 0.41no | 0.36o | 0.27p | 0.37E | 0.24o | 0.22o | 0.16p | 0.15p | 0.19E |
| 3. | 0.94l | 0.93l | 0.81m | 0.75m | 0.86D | 0.48k | 0.46l | 0.43m | 0.39n | 0.44D |
| 5. | 2.15i | 2.11i | 1.96j | 1.88k | 2.03C | 1.12g | 1.08h | 0.95i | 0.91j | 1.02C |
| 7. | 2.90e | 2.81f | 2.73g | 2.63h | 2.77B | 1.45d | 1.43d | 1.31e | 1.22f | 1.35B |
| 9. | 3.68a | 3.51b | 3.43c | 3.32d | 3.49A | 1.82a | 1.75b | 1.64c | 1.11g | 1.58A |
| **Mean | 2.02A | 1.95B | 1.86C | 1.77D | | 1.02A | 0.99B | 0.90C | 0.76D | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Table 12: Effect of nitrogen form on (Cl mg/g D.W.) of shoots and roots of *Salix babylonica* under different levels of salinity during the seasons 2018/2029 and 2019/2020

| Character / Nitrogen form / Salinity ($dsm^{-1}$) | (Cl mg/g D.W.) shoots | | | | | (Cl mg/g D.W.) roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| First season (2018/2019) | | | | | | | | | | |
| Control | 1.42f | 1.22h | 0.81j | 0.52k | 0.99E | 0.76g | 0.66j | 0.45m | 0.25n | 0.53E |
| 3. | 1.63d | 1.45f | 1.20h | 0.97i | 1.31D | 0.82e | 0.73h | 0.66j | 0.47l | 0.67D |
| 5. | 1.81c | 1.59d | 1.36g | 0.96i | 1.43C | 0.91d | 0.79f | 0.68i | 0.50k | 0.72C |
| 7. | 2.15b | 1.80c | 1.42f | 1.22h | 1.65B | 1.16b | 0.82e | 0.73h | 0.66j | 0.84B |
| 9. | 2.43a | 2.14b | 1.79c | 1.52e | 1.97A | 1.16b | 1.92a | 0.92c | 0.77g | 1.19A |
| **Mean | 1.89A | 1.64B | 1.32C | 1.04D | | 0.96B | 0.98A | 0.69C | 0.53D | |
| Second season (2019/2020) | | | | | | | | | | |
| Control | 1.52j | 1.27l | 1.13m | 0.90n | 1.21E | 0.86i | 0.66m | 0.56o | 0.47p | 0.64E |
| 3. | 1.70h | 1.50j | 1.37k | 1.23l | 1.45D | 0.95g | 0.77k | 0.64n | 0.64n | 0.75D |
| 5. | 1.93e | 1.64i | 1.53j | 1.37k | 1.62C | 1.18c | 0.86i | 0.73l | 0.64n | 0.85C |
| 7. | 2.33c | 2.16d | 1.89ef | 1.79g | 2.04B | 1.25b | 1.13e | 0.93h | 0.82j | 1.03B |
| 9. | 2.60a | 2.40b | 2.20d | 1.85f | 2.26A | 1.32a | 1.16d | 1.08f | 0.86i | 1.11A |
| **Mean | 2.02A | 1.79B | 1.62C | 1.43D | | 1.11A | 0.92B | 0.79C | 0.69D | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

Table 13: Effect of nitrogen form on Ca% of shoots and roots of *Salix babylonica* under different levels of salinity during the seasons 2018/2029 and 2019/2020

| Character / Nitrogen form / Salinity ($dsm^{-1}$) | Ca % shoots | | | | | Ca % roots | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Control | N1 | N2 | N3 | *Mean | Control | N1 | N2 | N3 | *Mean |
| First season (2018/2019) | | | | | | | | | | |
| Control | 0.38n | 0.68l | 1.47h | 1.60f | 1.03E | 0.16o | 0.21n | 0.48h | 0.50g | 0.34E |
| 3. | 0.58m | 0.88k | 1.54g | 1.80e | 1.20D | 0.20n | 0.30m | 0.57f | 0.58f | 0.41D |
| 5. | 0.88k | 1.18j | 1.85e | 2.15d | 1.52C | 0.32m | 0.34l | 0.65e | 0.76c | 0.52C |
| 7. | 1.14j | 1.14j | 2.14d | 2.39b | 1.70B | 0.37k | 0.39j | 0.72d | 0.78b | 0.57B |
| 9. | 1.32i | 1.45h | 2.20c | 2.45a | 1.86A | 0.45i | 0.49gh | 0.75c | 0.81a | 0.63A |
| **Mean | 0.86D | 1.07C | 1.84B | 2.08A | | 0.30D | 0.35C | 0.63B | 0.69A | |
| Second season (2019/2020) | | | | | | | | | | |
| Control | 0.75p | 1.13n | 1.39k | 1.76g | 1.26E | 0.42i | 0.47h | 0.47h | 0.61d | 0.49E |
| 3. | 0.95o | 1.19m | 1.60i | 1.82f | 1.39D | 0.47h | 0.48gh | 0.54e | 0.63d | 0.53D |
| 5. | 1.27l | 1.42j | 1.63h | 1.87e | 1.55C | 0.50fg | 0.51f | 0.56e | 0.65c | 0.56C |
| 7. | 1.43j | 1.63h | 1.91d | 2.23b | 1.80B | 0.62d | 0.62d | 0.66c | 0.77a | 0.67B |
| 9. | 1.75g | 1.77g | 2.15c | 2.34a | 2.00A | 0.67c | 0.67c | 0.72b | 0.79a | 0.71A |
| **Mean | 1.23D | 1.43C | 1.74B | 2.00A | | 0.54D | 0.55C | 0.59B | 0.69A | |

Means within column or within row having the same letter are not significantly differences according to Duncan multiple rang test (DMRT).
*Main treatment (salinity levels) **Sub treatment (N. form)
N1 (Ammonium sulphate), N2 (Ammonium nitrate), N3 (Calcium nitrate)

to overcome destructive effect of salinity [56]. It is worth that $Ca(NO_3)_2$ contains in its composition very similar contents of Ca and N (19% of Ca and 15.5% of N), it is not possible to separate the individual effect of these nutrients. Therefore, plant response was attributed to their joint effect. Nitrogen is a macronutrient found in organic compounds such as amino acids and nucleic acids and participates in various physiological processes in the plant life cycle, such as ionic absorption, photosynthesis, respiration and cell multiplication and differentiation [57]. Calcium, in turn, is a constituent of the cell wall and acts in most processes of growth, development, maintenance and reproduction, being responsible for the mechanical resistance of vegetal structures, promotion of junction of cells and exoskeleton, besides controlling high turgor pressures and acting in the protection against physical and chemical injuries [58]. In addition, increment of Ca content in leaf tissues can increase photosynthetic capacity and also chlorophyll synthesis [59]. Hence, using Ca in the nutrient solution can be one method to reduce some physiological imbalances due to salinity, such as the absorption of micro- and macroelements [60].

## CONCLUSION

From the obtained results, it can be concluded that there was a significant and gradual decrease in all of the studied growth parameters (seedling height, stem diameter, fresh and dry weights of shoots and roots, as well as number of branches and leaves) by increasing salinity levels to ($9dSm^{-1}$) when compared to control grown under non –saline condition which recorded the highest values for the previous parameters.

Calcium nitrate was the best source of N fertilizer which gave the highest values for all of the growth parameters. Also, all combinations between different sources of nitrogen fertilizers at the lowest level of salt ($3\ dSm^{-1}$) enchanced most vegetative growth traits of *Salix babylonica* in the two seasons and it was notably by using calcium nitrate at salinity level ($3\ dSm^{-1}$).

- The data revealed that salinity stress caused a depressive effect on total chlorophylls at the highest salinity level($9dSm^{-1}$) compared to control. Also, calcium nitrate surpassed to other forms of N. As well as, the effect of interaction between salinity levels and different forms of N for both seasons at salinity level ($3\ dSm^{-1}$) showed that calcium nitrate recorded the highest value for total chlorophylls. Also, the results showed a progressive effect on total sugars and proline which significantly increased by increasing salinity level and calcium nitrate was the best form of N fertilizer for total sugars and proline in both seasons. Furthermore, the effect of interaction between salinity levels and different forms of N revealed that at salinity level ($9dSm^{-1}$) with calcium nitrate recorded the highest values for total sugars and proline.
- Also, concentrations of N, P and K decreased with increasing salinity level ($9dSm^{-1}$) in the two seasons. In addition, the data recorded increases in N, P and K concentration by using calcium nitrate and it was the best source of N fertilizers compared to other forms .and the lowest level of salinity( $3dSm^{-1}$) in combined with calcium nitrate as a source of N fertilizer achieved the highest values of N, P and K concentrations.
- Concentration of Na and Cl showed significant increases by increasing salinity levels and ammonium sulphate gave the highest concentration in both elements, in both seasons, compared to other sources of N fertilizers. The interaction effect between salinity levels and different forms of N, revealed that the applied rate ($9dSm^{-1}$) of salinity with ammonium sulphate fertilizer exhibited higher values of Na and Cl concentration in shoots and roots in the two seasons . Moreover, the concentration of Ca increased by increasing level of salinity and calcium nitrate gave the highest concentration of Ca compared to other forms of N. The combined treatment between salinity level ($9dSm^{-1}$) and calcium nitrate fertilizer increased Ca concentration.

Therefore, it can be refered that part of the ameliorative effects of nitrogen sources on salinity adverse effects of the present study indicate that nitrogen in the form of calcium nitrate was the best type of N, to reduce the harmful effects of salinity stress.

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