The Effects of Salinity on the Accumulation of Elements in *Senna italica* Leaves

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Abstract: ***The influence of different concentrations of sodium chloride at 0 (control), 10, 20, 50, 100, 150, and 200 mM. on elements accumulation of Senna italica Mill leaves was studied. The plant internal levels of the essential elements were remarkably affected by salinity. Total nitrogen contents of leaves slightly increased at salinity of 10 mM, while decreased with the increased salinity, comparing to the control. Phosphorus content of leaves was not significantly affected by the different treatments. Sodium accumulation in leaves was remarkably enhanced by salinity. By the fourth harvest sodium level reached (8 - 10), (9 - 11) and (8 - 10) folds in leaves as compared to the control. Potassium and magnesium contents of leaves increased at salinity of 10 and 20 mM but decreased at higher levels of salinity and as plant aged, comparing to the control. Calcium accumulation in leaves enhanced under salinity of 10 - 50 mM in most harvests as salinity increased. Iron content of leaves reduced by salinity especially at levels higher than 100 mM. Zinc content decreased in leaves as salinity increased and plant aged. Copper level in leaves was not significantly affected by treatments. Chlorides accumulated in leaves, as salinity increased. By the fourth harvest their levels attained 5.4 folds in leaves, as compared to the control. Finally. Senna italica could tolerate salinity at levels of 10 - 50 mM. The plant accumulated sodium, chlorides, at high levels in the leaves as a physiological mechanism to tolerate salinity. In addition, since phosphorous, potassium and magnesium were not significantly affected, this may be a good tool in plant growth in saline environment.***

Keywords: *Senna italica*, salinity, elements accumulation, physiological mechanism, tolerate salinity

1. Introduction

In arid and semi-arid regions, soil salinity is more common than in humid regions due to salt stress. Farming, forestry, pasture development, and other similar practices suffer from salinity. Salinity is a scourge for agriculture, forestry, pasture development and other similar practices. It is very important to understand how plants respond to salinity. Plants will not grow well in high salt concentrations (Wenping *et a*l., 2022 & Hamna, *et al*. 2019), and excessive salt concentrations will kill them (Yadav, *et al*., 2011). The germination and growth of seedlings at high salinities have been reported to be retarded (Bernstein, 1963 & Ramoliya and. Pandey.2003). There is, however, some variation between plant species when it comes to salt tolerance or sensitivity (Parida, and Das, 2005). There are several types of salts and an equally diverse set of mechanisms for avoiding or tolerating them. Furthermore, plants exhibit different levels of environmental tolerance at various developmental stages (Munns, 2002 & Ashraf et al., 1986). The growth of shoots is suppressed more by soil salinity than that of roots, according to many researchers (Joseph *et al*., 2017). There are, however, few studies examining the effects of soil salinity on root growth (Garg and Gupta, 1997). The high salt content lowers osmotic potential of soil water and consequently the availability of soil water to plants. In saline soil, salt induced water deficit is one of the major constraints for plant growth. As soils dry down soil salinity is exacerbated. In saline deserts like Saudi Arabia, droughts are a regular occurrence. Eventually, responses of roots and shoots of plants to soil salinity should be understood under both wet and dry soil conditions. Additionally, salt-stressed plants can experience many nutrient interactions that may affect growth. Nutrient concentrations and their uptake have frequently been studied at the internal level (e.g. Robert and Julie, 2003, and Cramer, 2002), there is a complex relationship between soil salinity and micronutrient concentrations, but this relationship is poorly understood. (Tozlu *et al*., 2000).

NRCS (2015) describes the *Italian senna as "The Port Royal Senna"*, a legume of the *Senna genus.* In addition to its common name, it has many other names depending on where it grows. This plant is used to make "neutral henna", a powder for treating hair-related diseases in India. However, in some countries, such as Saudi Arabia, this species (along with *Cassia senna*) is cultivated for the leaves that contain the laxative drug senna, commonly known as Senna glycoside. Plants of this genus are classified according to the size of inflorescences and petioles. The subspecies are italica, and arachnoids. Medicinal and commercial cultivation of this plant are common in many regions.

2. Material and Methods

Senna italica seeds have been collected from Makkah region of Saudi Arabia (where it is dominant). After being soaked in sulfuric acid, the seeds germinated in sandy soil until seedlings appeared. Then the seedlings were taken and placed in plastic containers. Senna italica leaves were analyzed with various concentrations of sodium chloride, including zero (control), ten (10), twenty (20), fifty (50), one hundred and fifty (150) and two hundred (200). The experiment was conducted in a special growth chamber at a temperature of 23 ^{0}C. The lighting rate is 12 hours, and each pot contains 30 seeds. Following the stabilization of the seedlings and their growth for 44 days, salt concentrations were added. Afterwards, the seedlings were left in the treatments for 7 days, and then the first harvest was taken, followed by three harvests every 7 days. The elements were then analyzed. Therefore, the age of the seedlings at the time of the first harvest was 51 days, the age of the seedlings at the time of the second harvest was 58 days, the age of the plants at the time of the third harvest was 65 days, and the age of the plants at the time of the fourth harvest was 72 days. .

2.1 Determination of Macro elements in Leaves:

At a certain age, leaves were randomly collected from each treatment, and these are called first (51 days), second (58 days), third (65 days) and fourth (72 days) harvest. Using a drying oven, the leaves were dried and ground into a fine, homogeneous powder. Following this, the samples were digested in concentrated sulfuric acid and Perchloric acid in accordance with (Humphries, 1956). The ground plant sample is placed in a digestion tube and dissolved in concentrated sulfuric acid for one minute. In the gas cabinet, the digestion tube is placed on a heater for 5 minutes until the plant sample is charred and becomes a homogeneous black liquid. Add concentrated sulfuric acid and Perchloric acid (1: 1) to the sample in a ratio of 1 ml each. In the next step, it is heated until it turns into a clear liquid (colorless, transparent). To make the measurements, wash and shake the digestion tube until cool, transfer the liquid to a standard flask with a volume of 50 ml, add distilled water, and strain the solution into plastic bottles. This solution was then analyzed using an atomic absorption photometer (Atomic Absorption Photometer 3100 Perkin Elmer). In addition to sodium, potassium, magnesium, calcium, iron, zinc, and copper, there were also a few other elements.

2.2 Determination of Total Nitrogen in Leaves:

Total nitrogen was determined in leaves following the procedure of Delory (1949) using Nessler's reagent. In order to determine nitrogen, 1 ml of digested sample and 4 ml of distilled water is taken. The sample is placed in a standard flask with a volume of 50 ml, and 3/4 of the volume of the standard flask is filled with distilled water. Then 1 ml of Nessler's solution is added. Yellow color appear. As a second step, distilled water is added to the volume, shaken well, and the color intensity of the solution is measured with a spectrophotometer at a wavelength of 490 nm. To estimate the total nitrogen concentration in an unknown sample, a standard solution of nitrogen was prepared to obtain a standard curve**.**

2.3 Determination of Phosphorus in Leaves:

Using phosphor molybdate, the phosphorus concentration was determined calorimetrically according to Wood and Melon (1941).100 ml of distilled water was used to dissolve 5 grams of pure ammonium molybdat, which was then transferred to a 200 ml flask. To this solution, 42.6 ml of concentrated sulfuric acid with a density of 1.48 and 200 ml of distilled water were added. It is measured at 660 nm using a spectrophotometer.

2.4 Determination of Chlorides in Leaves:

Chlorides were determined by extracting them from samples burned at a temperature of 500°C for 2-3 hours, then titrating the extract with silver nitrate according to Jackson and Thomas (1960) method.

Statistical Analysis:
Three replicates were made for each sample, and the results were treated statistically using the SPSS program, where a two-way analysis of variance was used.

3. Result

3.1 Effect of salinity on the nitrogen content of Senna italica leaves:

Table 1, indicated that the nitrogen content of the leaves increased slightly at low salinity (10 mmol), but this increase occurred after the first harvest, that is, at advanced ages compared to the control treatment. However, for the other treatments, the nitrogen concentration gradually decreased in the leaves of *Senna italica* plant as the salinity concentration in the external solution increased. As the age of the plant increased, most of the treatments recorded an increase in the concentration of nitrogen in the leaves, except for the last two treatments (150 and 200 mmol), where the nitrogen content of the leaves decreased with increasing age of the plant. Comparing all the salt treatments with the control treatment, we find that there is a decrease in the concentration of nitrogen with the late stages of growth.

Table 1: Effect of salinity on the Total Nitrogen accumulation in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error)

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	4.88±0.66	4.80±1.26	4.76±1.51	4.10±0.15	3.90±0.89	3.56±0.16	3.29±0.97
Second Harvest (58 days)	5.80±1.34	5.88±1.17	5.12±0.88	4.24±1.35	4.04±1.62	3.52±1.14	3.81±1.15
Third Harvest (65 days)	5.68±1.18	5.89±1.29	5.68±0.60	4.70±0.26	4.35±0.71	2.94±1.85	2.76±0.06
Fourth Harvest (72 days)	5.40±0.28	5.87±0.16	5.69±0.12	4.71±0.24	4.35±0.10	2.48±0.05	2.48±0.08

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.032, the interaction between them = 0.002

3.2 Effect of salinity on Accumulation of Phosphorus in *Senna italica* leaves:

The phosphorus accumulated in the leaf tissue of *Senna italica* plant grown in the different salt treatments was not significantly affected with increasing salinity compared to the control treatment (Table 2). As the age increased, we found that the amount of phosphorus in the leaves of *Senna italica* plant increased in the second harvest and then decreased in all treatments at the third and fourth harvests compared to the control treatment. It is noted that the amount of phosphorus is almost similar, whether between harvests or for one harvest. The values of phosphorus in the leaves ranged between 0.22 micrograms/gram dry weight in the first and second harvests in the leaves of the control treatment plants, and between 0.12 µg/g/ dry weight in leaves of plants at the highest salt treatment (200 mmol) at harvest 4.

Table 2: Effect of salinity on the accumulation of Phosphorus in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error)

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	0.22±0.05	0.13±0.01	0.17±0.02	0.17±0.03	0.14±0.02	0.14±0.02	0.18±0.01
Second Harvest (58 days)	0.22±0.04	0.21±0.01	0.21±0.02	0.21±0.04	0.16±0.01	0.16±0.01	0.14±0.03
Third Harvest (65 days)	0.17±0.01	0.16±0.01	0.18±0.02	0.19±0.06	0.13±0.01	0.13±0.01	0.13±0.01
Fourth Harvest (72 days)	0.16±0.02	0.13±0.01	0.15±0.03	0.14±0.02	0.13±0.02	0.13±0.02	0.12±0.01

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.150, theinteraction between them = 0.033

3.3 Effect of salinity on Accumulation of Sodium in *Senna italica* leaves:

Table 3 clarified that, Sodium accumulation gradually increased in the leaves of *Senna italica* plant with an increase in the concentration of sodium chloride in the external solution compared to the control treatment. Plants growing in the high salt treatment (100 mmol) accumulated the largest amount of sodium in their leaves. The increase was sharp after the first harvest in all treatments and continued until the fourth harvest, where the sodium level in the leaf reached about (8-10) times its level in the control treatment. It is also noted from Table 3 that sodium accumulation increases with increasing plant age within all treatments.

Table 3: Effect of salinity on the accumulation of Sodium in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error)

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	1.2±0.0	1.2±0.0	1.2±0.0	1.2±0.0	1.5±0.3	1.9±0.0	2.0±0.0
Second Harvest (58 days)	1.3±0.0	5.0±0.0	12.8±0.1	12.8±0.2	13.2±0.2	12.4±0.2	9.4±2.2
Third Harvest (65 days)	1.3±0.2	7.2±0.0	12.9±0.0	13.0±0.0	14.4±0.8	13.5±0.9	11.9±0.7
Fourth Harvest (72 days)	1.4±0.0	13.3±0.1	13.5±0.2	14.1±0.1	14.7±0.1	14.4±0.1	12.4±0.3

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.000, the interaction between them = 0.000

3.4 Effect of salinity on Accumulation of Potassium in *Senna italica* leaves

Results in Table 4 revealed that, accumulation of potassium in the leaves of the growing *Senna italica* plant at low salt concentrations (10 and 20 mmol) at concentrations higher than the control treatment in the third and fourth harvests. However, at higher concentrations of salinity, the amount of potassium accumulated in the leaves decreased with the increase in salinity outside. As the age of the plant increased, potassium accumulation increased in the growing leaves in the control treatment and the first three salt treatments (10-50 mmol), then the accumulation began to decrease with increasing plant age in the rest of the salt treatments.

Table 4: Effect of salinity on the accumulation of Potassium in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error).

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	48.5±2.0	30.9±6.5	30.9±6.5	32.4±4.7	32.4±4.7	32.4±4.7	34.5±6.2
Second Harvest (58 days)	50.4±8.0	45.1±1.0	45.1±1.0	40.1±1.5	40.1±1.5	40.1±1.5	30.1±5.1
Third Harvest (65 days)	52.3±4.5	63.2±3.0	63.2±3.0	40.9±3.8	40.9±3.8	40.9±3.8	29.4±3.2
Fourth Harvest (72 days)	59.2±3.6	66.8±9.1	66.8±9.1	41.5±2.8	41.5±2.8	41.5±2.8	12.6±1.3

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.001, the interaction between them = 0.000

3.5 Effect of salinity on Accumulation of Magnesium in *Senna italica* leaves:

It is noted from the results recorded in Table 5, that the accumulation of magnesium increased significantly in the leaves of the growing *Senna italic* plant at different concentrations of salinity with increasing age of the plant, except for the last two salt treatments (150 and 200 mmol), where it decreases after the second harvest. As for the control treatment, thequantity remains constant with age. Table 5 indicated that the highest amount of magnesium accumulated in the leaves of plants growing in the low salt treatments (10-50 mmol). It was higher than that accumulated in the control treatment, but it decreased with increasing salinity concentration.

3.6 Effect of salinity on Accumulation of Calcium in Senna italica leaves:

Calcium accumulated in a greater amount than in the control treatment in the leaves of Senna italica plant growing at low concentrations of salinity (10-50 mmol) in most crops, but it decreased with increasing salinity outside (Table 6). It is also noted that calcium accumulation in the leaves increases with increasing plant age in the first three treatments (control treatment-20 mmol) only. However, in the rest of the treatments, we notice a decrease in calcium in the leaves with increasing age at the third and fourth harvests compared to the previous harvests.

Table 5: Effect of salinity on the accumulation of Magnesium in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error).

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	12.2±0.4	12.2±0.4	12.1±0.1	12.4±0.2	12.2±2.1	11.7±0.3	11.9±0.3
Second Harvest (58 days)	13.0±0.6	12.7±0.9	13.5±2.6	13.8±1.1	13.6±4.7	13.5±6.5	12.1±1.4
Third Harvest (65 days)	13.7±0.2	13.7±0.1	13.9±0.2	14.2±0.1	13.7±0.1	13.3±0.0	12.9±0.1
Fourth Harvest (72 days)	13.7±0.0	15.1±0.5	15.2±0.2	15.4±0.1	13.7±0.1	12.4±0.1	11.5±0.2

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.000, the interaction between them = 0.000.

Table 6: Effect of salinity on the accumulation of Calcium in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error).

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	5.2±1.1	5.2±0.7	5.6±0.8	4.5±0.5	5.9±0.9	5.3±0.5	4.4±0.3
Second Harvest (58 days)	5.6±0.5	5.8±0.7	6.3±1.1	6.7±0.9	6.2±1.3	5.4±0.7	4.5±0.9
Third Harvest (65 days)	5.5±0.4	6.8±0.2	6.3±0.5	6.5±0.3	4.1±0.3	3.9±0.0	3.0±0.2
Fourth Harvest (72 days)	6.1±0.3	7.7±0.8	8.3±0.3	5.8±0.1	4.1±0.2	3.4±0.2	3.0±0.3

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.000, the interaction between them = 0.000

3.7 Effect of salinity on Accumulation of Iron in *Senna italica* leaves:

It is noted from Table (7) a decrease in the amount of iron in the leaves of *Senna italica* plant, especially at high concentrations (100-200 mmol), with increasing salinity and aging compared to the control treatment in most crops. We also notice a decrease in the amount of iron with increasing plant age in combination with salt treatments.

Table 7: Effect of salinity on the accumulation of Iron in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error).

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	0.18±0.04	0.17±0.01	0.17±0.01	0.17±0.01	0.18±0.03	0.17±0.02	0.17±0.03
Second Harvest (58 days)	0.15±0.01	0.14±0.02	0.14±0.02	0.14±0.02	0.18±0.03	0.13±0.01	0.12±0.04
Third Harvest (65 days)	0.13±0.00	0.15±0.01	0.15±0.01	0.15±0.01	0.08±0.00	0.08±0.01	0.07±0.01
Fourth Harvest (72 days)	0.09±0.01	0.09±0.00	0.09±0.00	0.09±0.00	0.08±0.01	0.07±0.02	0.08±0.01

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.000, the interaction between them = 0.000

3.8 Effect of salinity on Accumulation of Zinc in *Senna italica* leaves:

The results shown in Table (8) showed that the amount of zinc accumulated in the leaves of *Senna italica* plant decreased in all salt treatments with increasing salinity, especially with increasing age compared to the control treatment. As for the effect of treatments with increasing plant age, the amount of zinc accumulated in the leaves was almost constant in all salt treatments, including the control treatment.

3.9 Effect of salinity on Accumulation of Copper in *Senna italica* leaves:

Table (9) shows that the different salt treatments did not have a significant effect on the amount of copper accumulated in the leaves of *Senna italica* plant compared to the control treatment, even as the plant aged. Therefore, there is no significant difference between harvests or treatments, or any interaction between harvests and treatments.

Table 8: Effect of salinity on the accumulation of Zinc in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error).

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	0.49±0.00	0.35±0.05	0.33±0.06	0.35±0.13	0.35±0.07	0.32±0.03	0.39±0.10
Second Harvest (58 days)	0.46±0.03	0.39±0.10	0.44±0.15	0.43±0.08	0.32±0.08	0.25±0.05	0.35±0.20
Third Harvest (65 days)	0.45±0.14	0.40±0.06	0.41±0.14	0.42±0.10	0.22±0.10	0.25±0.08	0.29±0.04
Fourth Harvest (72 days)	0.42±0.10	0.38±0.09	0.37±0.12	0.31±0.08	0.22±0.10	0.23±0.02	0.19±0.11

The least significant difference is at the 5% significance level. Between harvesters = 0.303
Between treatments = 0.032, the interaction between them = 0.017

Table 9: Effect of salinity on the accumulation of Copper in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error).

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	0.17±0.01	0.14±0.09	0.18±0.01	0.17±0.02	0.14±0.05	0.12±0.01	0.12±0.01
Second Harvest (58 days)	0.11±0.00	0.11±0.00	0.18±0.04	0.17±0.02	0.19±0.03	0.14±0.02	0.14±0.02
Third Harvest (65 days)	0.11±0.00	0.11±0.00	0.11±0.00	0.11±0.00	0.20±0.03	0.19±0.01	0.19±0.01
Fourth Harvest (72 days)	0.15±0.06	0.18±0.03	0.13±0.00	0.13±0.01	0.20±0.00	0.11±0.00	0.11±0.00

The least significant difference is at the 5% significance level. Between harvesters = 0.061
Between treatments = 0.268, the interaction between them = 0.049.

3.10 Effect of salinity on Accumulation of Chlorides in *Senna italica* leaves:

Chlorides accumulated in the tissues of growing plants at different salinity concentrations (Table 10). In the leaves, the least amount of chlorides was recorded in the plants growing in the control treatment, then the concentration gradually increased significantly with increasing salinity outside, as the leaves of the plants growing in the high salt treatment (200 mmol) accumulated the largest amount of chlorides, reaching in the fourth harvest about (4.5) times the control treatment. Chlorides also increased in leaves with increasing plant age in different treatments.

Table 10: Effect of salinity on the accumulation of Chlorides in *Senna italica* leaves (µg/g dry weight) a different growth stages (Mean ± Standard Error)

	Salt Treatments						
Plant's Age	Control	10	20	50	100	150	200
First Harvest (51 days)	1.4±0.0	5.0±0.1	6.2±0.1	10.3±0.4	15.4±0.4	22.1±0.2	24.8±0.1
Second Harvest (58 days)	3.5±0.1	8.5±0.1	6.5±0.2	12.8±0.2	17.0±0.2	25.3±0.2	26.5±0.2
Third Harvest (65 days)	4.1±0.0	9.2±0.0	11.0±0.2	15.7±0.3	23.5±0.1	29.4±0.2	33.1±0.2
Fourth Harvest (72 days)	6.5±0.0	9.9±0.0	12.5±0.0	16.7±0.1	23.8±0.5	33.0±0.3	35.0±0.2

The least significant difference is at the 5% significance level. Between harvesters = 0.000
Between treatments = 0.000, the interaction between them = 0.000

4. Discussion

The importance of elements in plants and their role in regulating physiological processes in different tissues made it necessary to determine how salinity affects leaves. Salinity caused an increase in the amount of total nitrogen at low salt treatment (10 mmol) compared to the control, then the decrease appeared with increasing salinity concentration. As for the phosphorus content in the leaves, the amount of phosphorus in the leaves was not significantly affected by the different salt treatments compared to the control. It is noted that the amount of phosphorus is similar in both salt treatments and crops, except for the highest treatment (200 mmol). However, there was a significant decrease in the fourth harvest compared to the control.

As a way to regulate osmoregulation, some researchers hypothesize that plants growing in salty soil accumulate ions in their tissues. Increasing sodium chloride concentration causes sodium to accumulate in the leaves of *Senna italica* plants. The sodium concentration in the leaves increased 8-10 times compared to the control at the fourth harvest. It may be a way of maintaining proper osmotic potential, which is necessary for the plant to absorb water from the soil. Furthermore, it is also noted that this plant accumulates sodium to a certain extent, despite the increasing concentration of salts outside, in order to limit reaching the dangerous level inside. This phenomenon is prevalent in halophytic plants and other plants as well (Al-Zahrani, 1990). Potassium levels in the leaves decrease with age in medium and high salinity treatments (third and fourth harvests). As salinity in the external environment increases, potassium absorption and accumulation decreases because of the opposition between sodium and potassium. Many plants exhibit this clear relationship between sodium and potassium (Parida and Das, 2005 & Rivelli et al., 2010). Plant magnesium content remained similar in most salt treatments, with the exception of high salt treatments (150 and 200 mmol), where magnesium concentration decreased. These results are similar to what have been recorded in many plants, Viz., Sunflower (Kader and Lindberg, 2010). It is possible that such a decrease in magnesium levels is caused by an imbalance in the ionic balance within plant tissues that are subject to salt stress and drought stress, which negatively impacts plant growth. Observations have shown that calcium accumulation in the leaves increases at low salt levels for the majority of harvests and gradually decrease with increasing salinity for the remaining harvests. Many researchers have recorded the existence of an ionic imbalance that leads to a decrease in many elements, including calcium. Calcium is considered as an essential element in most plants processes (Malihe, *et al.*, 2023 & Cramer, *et al.*, 1985). The permeability of the plasma membrane is affected by NaCl, and external ions are influxed into plant cells as well as cytosolic solutes are effluxed (Vahid et al., 2008). Furthermore, NaCl hardens the cell wall (Jinhua et al., 2023) and decreases plasma membrane water conductance. Regarding the plant's iron content, its quantity was small in the leaves of *Senna italica* plant, especially in high salt treatments as the plant aged compared to the control treatment. Salinity caused a decrease in the plant's zinc content in all salt treatments, especially as the plant aged compared to the control treatment. However, some authors have reported a beneficial effect of Zn in improving salinity tolerance (Marschner, 2011).

The amount of copper in the plant leaves was not significantly affected by salinity compared to the control treatment, even as the plant aged. This may consider as good tool in salt stressed conditions. Cu also protects plants from oxidative damage as itis integral component of isoform of superoxide dismutase (Muhammad *et a*l., 2018 and Franco-Navarro, *et al.*, 2016).

Chlorides increased in the tissues of growing plants with increasing salinity concentrations, as the highest accumulation amount was at the highest concentration at the fourth harvest, it doubled in leaves compared to the control treatment. It has been noted that this accumulation is needed by the plant for osmotic control. Chloride (Cl^-), the anion of the halogen element chlorine, is a micronutrient for higher plants (Muhammad *et al.*, 2018) and a beneficial macronutrient ion (Raven, 2017 & Chen et al., 2016). It involved in elongation growth (Gadallah, 1999).

We note from the above regarding the accumulation of various ions in the tissues of the *Cassia italica* plant at different concentrations of salinity, that the accumulation of sodium and chloride leads to competition in the absorption of other elements. This appeared clearly in potassium, which led to a sharp decrease in the accumulation of potassium, and then a deficiency or decrease in its quantity below the required limit for the plant's need. It was found that the accumulation of sodium and chloride led to a deficiency of many elements such as calcium, iron and chlorides. This is in consistent with the finding of Gadallah, (1999), (Khan et al., 1999) and (Salachna, and Piechocke, 2016). However, the essential elements like Phosphorus, magnesium and potassium accumulation was not significantly affected by salt treatments, and this agrees with what many researchers have found, such as (Ferreira, *et al.*, 2001). These elements help the plants in the saline environment. In the process of plant growth, phosphorus is an essential nutrient, and its effectiveness affects plant growth significantly (Wenping, *et al.*, 2022). Furthermore, calcium and magnesium are the most abundant cations in plants (Khulan, *et al.*, 2022) When soil Na concentrations are high; $Ca2+$ and $Mg2+$ are less available to plants, resulting in nutrient deficiencies. This is not the case in Senna italica. This considered as good phenomenon in Senna italica overcoming the saline environment of Saudi Arabia.

It is possible to apply the knowledge gained about plant growth and survival under natural habitat conditions for: (i) screening of plant species for afforestation of saline deserts, and (ii) understanding the mechanisms plants use in order to avoid or tolerate salt stress.

5. Conclusion

Senna italica accumulates sodium chlorides at high levels in the leaves as a physiological mechanism to tolerate salinity. Moreover, since phosphorus, potassium, and magnesium were not significantly affected, this may be a useful tool in saline environments like those in Saudi Arabia. The knowledge gained about plant growth and survival under natural habitat conditions can be applied to: (i) afforestation in saline deserts, and (ii) understanding the mechanisms plants use to avoid or tolerate salt stress.

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