Effect of silicon and nano-selenium on the chemical characteristics of the Egyptian Senna plant (*Cassia acutifolia*) under the influence of salt stress

Mustafa Hamid Atiyah Baydaa Rasheed Hilo Nadia Altaee

College of Agriculture - Al-Qasim Green University - Department of Horticulture and Landscape Engineering

Abstract

The experiment was conducted in one of the private nurseries - Babylon province - Nile Region during the growing season of 2022-2023, on seedlings of Cassia acutifolia plant (Cassia acutifolia), one month age and homogeneous in size after transforming them into pots with a diameter of 22 cm.To study the effect of two factors, the first factor is the salinity of irrigation water (1.3dS m^{-1}, 5 dS m^{-1}, 10 dS m^{-1})The second factor is spraying nano silicon and selenium at concentrations (0, 50,100) mg.L^{-1} to know the extent of Cassia acutifolia plant's tolerance to salt stress, and at any concentration of salt stress the medically effective compounds of the plant increase.Evaluation of the contribution of anti-stress agents in reducing irrigation water salinity damage, improving growth and the content of medically effective compounds of Cassia acutifolia plant, and the interaction between factors on *Cassia acutifolia* plant in its content of active compounds.The experiment was conducted under the same environmental conditions as a factorial experiment (3×5) with a split-plot arrangement according to the Complete Randomized Blokes Design (R.C.B.D) and with three replicates, where each replicates contains 15 treatments with 5 seedlings per experimental unit. Salt stress represented the main plates and such as spraying with silicon and selenium nanoparticles in the secondary plates, and the averages were compared using the least significant difference L.S.D test at the level of 5%. The results of the experiment can be summarized as follows:Irrigation with salinity water (5 and 10) dSm-1 led to an increase in the amount of phenols, flavonoids, and proline, where the W2 treatment gave the highest content of total phenols in the leaves, reaching 0.94 mg-g^{-1}, dry weight.While the W2 treatment gave the highest content of flavonoids, reaching 39.50 mg-g^{-1} dry weight, while the W2 treatment gave the highest proline content in the leaves, reaching 4.18 mmol/g fresh weight. Spraying with selenium and silicon significantly reduced the amount of phenols, flavonoids and proline in plant leaves.Spraying with selenium and silicon led to a significant increase in the percentage increase (nitrogen, phosphorus and potassium) in the leaves of the Cassia acutifolia plant .As for the interaction between the experimental factors, salt stress, silicon, and selenium, it reduced the effects of salinity and increased the percentage (of nitrogen, phosphorus, and potassium). The control treatment outperformed and gave the highest percentage of nitrogen in the leaves, reaching 8.76%. The control treatment excelled and gave the highest percentage of phosphorus in the leaves, reaching 8.76%. 0.97%. The control treatment also excelled and gave the highest percentage of potassium in the leaves, reaching 1.89%. Corresponding to a decrease in (phenols, flavonoids, and proline.(

key words Cassia acutifolia, selenium and nano silicon, salt stress

introduction

The Egyptian Cassia plant, Cassia acutifolia, belongs to Fabaceae family, where it is used as a medicinal plant because its leaves, fruits and seeds contain anthraquinone glycosides and their derivatives, which consist of Aloe emodin and Rheing (resins), both of which are found bound or free and together form a different glycoside form, as Cassia leaves contain % 2-4 glycosides .The Egyptian cassia plant has several medicinal uses, as it acts as a stimulant for the muscle layer of the intestinal wall, which is why it is used as a laxative for cases of chronic constipation. In addition to its medicinal benefits, it is used as an ornamental plant to decorate parks and streets [5]It is also native to South Asia, from southern Pakistan eastward through India to Myanmar and south to Sri Lanka. It is grown as an ornamental plant on large scales in tropical and subtropical regions. This plant has been used traditionally in many countries for food and medicinal uses, where bark and leaves are anti-bleeding .Egyptian Cassia belongs to Fabaceae family and prefers hot and dry climates, hence it can be easily found in tropical climates in India, Sri Lanka and Myanmar [35]It has multiple medical uses as a medicine for diabetes, as it has a high economic value. Cassia acutifolia is widely used in traditional medicine for rheumatism, diarrhea, female infertility as well as for skin diseases [29] Salinity is a major problem facing the agricultural sector in water and soil that contain a high percentage of salts, and it has a direct impact on plant growth and flowering in conditions of high salinity [36].The highest salt concentration at which a plant can grow naturally is (2.5) dS/m. If we expose plants to salt concentrations higher than this concentration, their physiological functions and growth are negatively affected, as functional impairment occurs due to salt stress [34] .Most of the previous research and studies that were conducted to study the effect of salts on plant growth focused on using sodium chloride salt as a source of salinity, Where it is considered the most important source of salinity in the soil, as its effect is on the water relationship between the plant and the soil, as increasing its concentration leads to a decrease in the osmotic potential of the soil solution and thus reducing the strength. Water absorption by plant roots [7].Environmental phenomena, the most important of which is salinity, affect the various stages of plant development, affecting its morphology and its various physiological functions through their physical and chemical traits .Two of the elements that resist salt stress are selenium and silicon. Selenium was discovered in 1817 by the Swedish scientist Joins Jacob Berzelins in one of the sulfuric acid production plants. This element is a catalyst in some antioxidant enzymatic systems [11].One of its rare characteristics is that it possesses the phenomenon of opposite magnetism, as it creates a magnetic field that opposes any other external magnetic field, where it works to reduce the magnetic moment of free radicals, which is harmful and disruptive to the electronic balance, as it works to suppress the action of free radicals, resulting in flow lines that have a high ability and speed to penetrate. [30] .As for the silicon element, its role is to alleviate many biotic and abiotic stresses by incorporating it into many fertilizers and providing a physical and biochemical defense system. Silica deposition was investigated as a physical barrier to penetration and reduced susceptibility to enzymatic degradation by fungal pathogens [38]The trait of salt tolerance is not a simple phenomenon because it is an association of a group of physiological and genetic traits that are linked to more than one gene. Trait of salinity is also linked to a number of genes that are inherited from one generation to another, and gene expression has become an important tool in studying how living organisms respond to environmental changes, as plants have the ability to change the levels of gene expression in response to environmental changes such as high temperatures, salinity, drought, or the presence of harmful levels. Of toxic ions, and sometimes these transcriptional changes are an indication of successful adaptations of plants that lead to tolerance to stress, while there are plants that fail to adapt to the new environment that are sensitive to these changes in stressful environments[21].

Materials and methods

The experiment was coundected in one of the private nurseries - Babylon province - Nile Region during the growing season of 2022-2023, using seedlings of the Egyptian cassia plant (Cassia acutifolia) that were one month age and homogeneous in size after transferring them to pots with a diameter of 22 cm. A medium of river sand, peat moss, and decomposed organic fertilizer in the following ratios (1:1:2) was used to study the effect of stress resistances (silicone and selenium) on the tolerance of the Egyptian cassia plant to salt stress and its content of some secondary metabolic compounds.

The experimental parameters were as follows:

The first factor is salt stress

ISSN 2072-3857

The plants were watered with three salt concentrations by adding sodium chloride salt to the water, as follows:

1-The measurement factor for liquefaction water is 1.3 dSm-1 and is symbolized by W0

2- Treatment with water with a salinity of 5 dSm^{-1}, symbolized by W1

3- Treatment with water with a salinity of 10 dSm^{-1}, symbolized by W2

The second factor is anti-stress agents

The elements silicon and selenium were used, which work to reduce the damage of salt stress on the (Egyptian Cassia) plant by spraying them on the plants three sprays and fifteen days between one spray and the next, as follows:

1-control treatment without spraying.

2- Spraying with nano silicon at a concentration of 50 mg/L and symbolized by the symbol Si1.

3- Spraying with nano silicon at a concentration of 100 mg/L, symbolized by the symbol Si2.

4- Spraying with nano-element selenium at a concentration of 50 mg/L, symbolized by the symbol Sl1.

5- Spraying with nano-element selenium at a concentration of 100 mg/L, symbolized by the symbol Sl2.

The experiment was conducted under the same environmental conditions as a two-factor experiment (3 × 5) in a split-plot arrangement according to the Complete Randomized Blocks Design (R.C.B.D.) and with three replicates, where each replicate contains 15 treatments, with 5 seedlings for each experimental unit. Salt stress represented the main plot and spraying with silicon and nano-selenium in the sub plot. The averages were compared using the least significant difference (LSD) test at the 5% level [9]

1- Estimate the percentage of nitrogen

The total nitrogen percentage was estimated by distillation after adding 10 M sodium hydroxide in the Kjeldahl-Micro device, as stated in (Jackson, 1958), after titration with 0.04 M hydrochloric acid. The nitrogen percentage was estimated according to the following equation:

Nitrogen (%) = (Nitrogen equivalent weight x volume of acid consumed x its titre)/1000 x (total volume of sample)/(volume used for estimation) x 100/(weight of digested sample)

2- Measure the percentage of phosphorus

The determination was made using ammonium molybdate-vandate in concentrated nitric acid HNO3, where 22.5 g of ammonium molybdate was dissolved in 400 ml of distilled water (solution A), and 1.25 grams of ammonium vanadate was dissolved in 300 ml of hot distilled water (solution B), then it was determined. Add solution B to A and leave the mixture until it cools, then add 250 ml of concentrated nitric acid to it and leave the mixture until it reaches room temperature, then increase the volume to a liter. Take 5 ml of the digested sample and add 5 ml of molybdate-vandate solution to itammonium and complete the volume to 50 ml, then the sample was left for 30 minutes, after which the intensity of the optical absorption was measured in a spectrophotometer at a wavelength of 410nm and Blank was prepared in the same way, but without adding the sample, the standard curve was prepared By using potassium dihydrogen phosphate (KH2PO4) as in Scheme (1), then the concentrations were attributed to the percentage.

ISSN 2072-3857

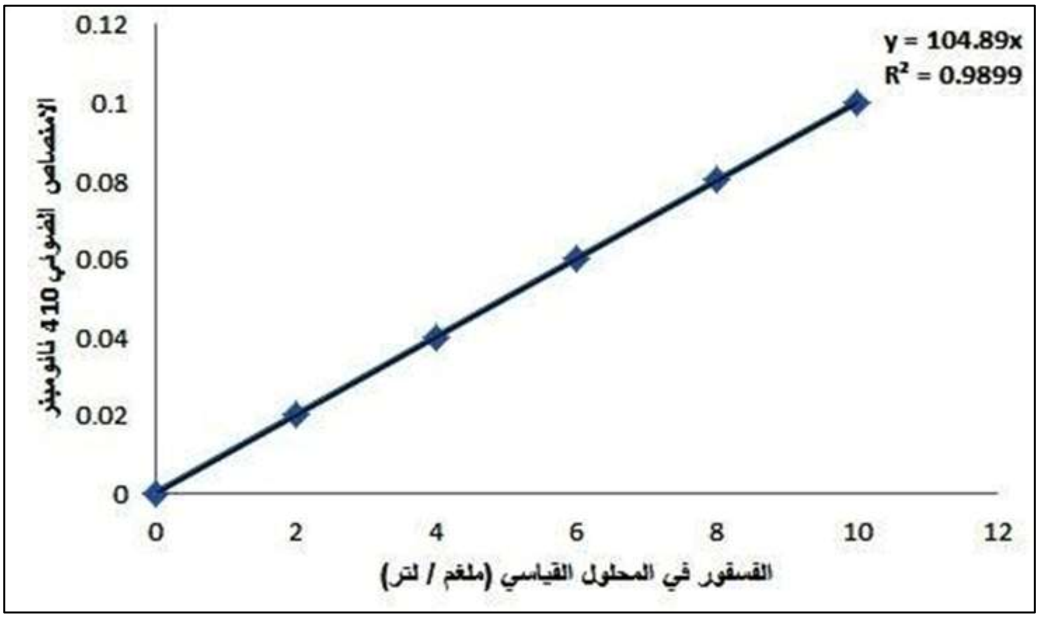

Figure (1): A diagram showing the standard curve for phosphorus

3- Percentage of potassium

Potassium was measured using a flame photometer, and digested samples were used for analysis. We turned on the gas and turned on the device, and the color of the flame became blue. We placed the sample under the tube of the device, which draws out the sample solution and turns it into a spray. Then the atoms of the sample glowed with the flame until a straight line signal appeared on the device screen, and the absorbance length was read. When using this method, the following must be taken into account:

1- Before using the device, put distilled water under its tube.

2-The sample must be purified of impurities using filter paper to ensure that the tube is not clogged and that distilled water does not run out.

3- Observe and adjust the stability of the device's flame until the blue color disappears.

4- When the concentration of potassium excelled the permissible limit, the word "Over" appears, then we must dilute the solution using the dilution equation.

4- Measurement of total phenols in leaves (mg.g^{-1} dry weight)

The method followed by Liu et al. (2011) was adopted by taking 0.5 ml of the extract for each treatment and placing each in a test tube, then adding 3 ml of Folin-Ciocatleu reagent diluted to a concentration of (0.1), then adding 2.5 ml of sodium carbonate (Na2Co3). Sodium carbonate (concentration of 0.2% (w/v), then mixed well and left the test tubes for three minutes at room temperature, then took an optical absorption reading using a spectrophotometer at a wavelength of 750 nm. Blank was also prepared in the same methods without adding the sample extract. The standard curve was prepared using gallic acid (C7H6O5 Gallic Acid), and the straight line equation was extracted as in Figure (2).

ISSN 2072-3857

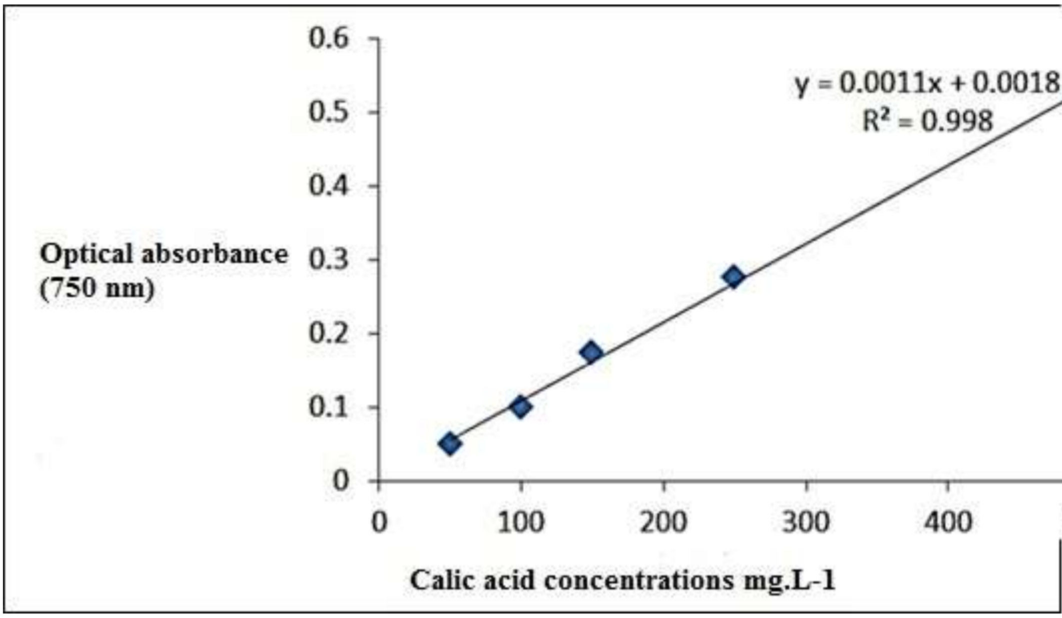

Figure (2): A chart showing the standard curve for total phenols

-5 Flavonoids were determined ($mg.kg^{-1}$ dry weight)

According to the method approved by (Liu et al., 2011), by taking 0.5 ml of the sample extract and putting it in a test tube, then adding 2.5 ml of ethanol to it, then mixing it well, then adding 3 ml of aluminum chloride (AlCl3), concentration of 0.01 $mol.L^{-1}$. The test tube where left for ten minutes at room temperature, and the intensity of optical absorption was measured with a spectrophotometer at a wavelength of 400 nm. Blank was also prepared in the same way without adding the sample extract. The standard curve was prepared using the substance Rutin, then extracting the equation of the straight line as in the figure (3).

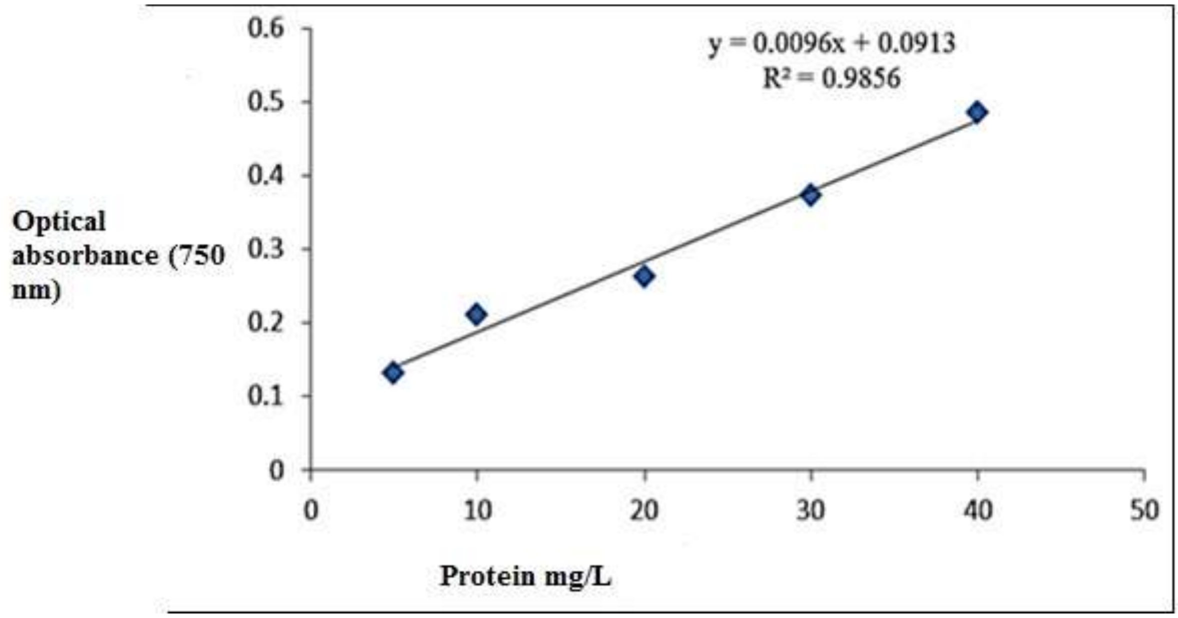

Figure (3): A chart showing the standard curve for total flavonoids

7- Proline measurement (mg/g dry weight)
Proline acid in leaves (mmol/g fresh weight) was determined according to the method (Bates, 1973) by using ninhydrin acid.
Solutions used:
1-Toluene dye.
2- Ninhydrin acid. It is prepared by dissolving 1.25% of it in 30 ml of glacial acetic acid and 20 ml of 6M glacial phosphoric acid, and then it is stored in the refrigerator at a temperature

ISSN 2072-3857

of 4 degrees Celsius for 24 hours in a dark environment.

3- Sulfosalicylic acid %3: We take 100 mg of the dried, ground sample and crush it using a glass mortar with 10 ml of sulfosalicylic acid 3%. The mixture was filtered using filter paper, after which 0.5 ml of the filtrate was taken and placed in test tubes, then 2 ml of sulfosalicylic acid was added to it. of glacial acetic acid and 1.5 ml of sulfosalicylic acid, then shake the tubes lightly for 10 seconds and add 2 ml of acidified ninhydrin solution (prepared by dissolving 1.25 ml of ninhydrin in 30 ml of concentrated glacial acetic acid and 20 ml of 30% phosphoric acid), then shake the tubes. Once again, it was placed in a water bath at a temperature of 95 degrees Celsius for an hour. The tubes were removed and placed directly in the ice grits for a quarter of an hour. Then they were taken out and left to come to room temperature. Then we put 4 ml of the coloring dye to separate the prolene layer. It was shaken using a Vortex device for 30 minutes. seconds, then leave the tubes for 5 minutes to settle. We withdraw the upper layer with a pipette and measure it with a spectrophotometer at a wavelength of 520nm, and then we calculate the proline concentration using a standard graph.

statistical analysis :

The results were analyzed using the ready-made statistical analysis program Genstat, and the means were compared according to the least significant difference (L.S.D.) test at the 5% probability level.

Results and Discussion

1- Percentage of nitrogen in leaves (%)

The results in Table (1) showed that there were significant differences between the control treatment and the salt stress treatments, where the control treatment excelled and gave the highest percentage of nitrogen in the leaves, amounting to 8.76%, followed by the W1 treatment, which gave a percentage of nitrogen in the leaves amounted to 7.11%, compared with W2, which gave the lowest percentage of nitrogen in the leaves, amounting to 7.11%. 5.73%, where the table shows that there are significant differences in the treatments of spraying nano-elements in trait of the percentage of nitrogen in the leaves, where Si2 treatment gave the highest rate of nitrogen in the leaves amounted to 7.81% compared to the control treatment that gave the lowest percentage of nitrogen in the leaves amounted to 6.84%. The interaction between salt stress and spraying of nanoparticles, W0Si2 treatment excelled in giving the highest rate of nitrogen in the leaves amounted to 9.30% compared to treatment W2S0 the lowest percentage of nitrogen in the leaves amounted to 5.06%.

Table (1): The effect of salt stress and spraying with nanoparticles on the percentage of nitrogen in the leaves of the Egyptian Cassia plant in the spring season 2022-2023 AD (%).

S average	W2	W1	W0	treatment
6.849	5.063	6.513	7.890	S0
7.209	5.640	7.127	8.860	Si1
7.815	6.503	7.640	9.303	Si2
7.105	5.327	7.360	8.630	SL1
7.470	6.123	7.130	9.157	SL2
	5.731	7.119	8.768	w average
	S 0.1781	W×S 0.3271	W 0.2360	L.S.D 5%

2-Percentage of phosphorus in leaves (%)

The results in Table (2) showed that there were significant differences between the control treatment and the salt stress treatments, where control treatment excelled and gave the highest percentage of phosphorus in the leaves, amounting to 0.97%, followed by the W1 treatment, which gave a percentage of phosphorus in the leaves amounted to 0.91%, compared to W2, which gave the lowest percentage of phosphorus in the leaves amounted to 0.91%. 0.68%, where table shows that there are significant differences in the treatments of spraying nano-elements in trait of the percentage of phosphorus in the leaves, where treatment Si2 gave the highest average percentage of phosphorus in the leaves amounted to 0.92% compared to the control treatment that gave the lowest percentage of phosphorus in the leaves amounted to 0.76%, while the treatments The interaction between salt stress and spraying of nanoparticles, W0Si2 treatment excelled in giving the highest rate of phosphorus in the leaves amounted to 1.03% compared to treatment W2S0, the lowest percentage of phosphorus in the leaves amounted to 0.53%.

Table (2): The effect of salt stress and spraying with nano-elements on the percentage of phosphorus in the leaves of the Egyptian Cassia plant in the spring season 2022-2023 AD (%).

S average	W2	W1	W0	treatment
0.7644	0.5300	0.8367	0.9267	S0
0.8622	0.7067	0.9167	0.9633	Si1
0.9289	0.7733	0.9767	1.0367	Si2
0.8388	0.6733	0.8933	0.9500	SL1
0.8966	0.7500	0.9433	0.9967	SL2
	0.6867	0.9133	0.9747	w average
	S 0.05538	W×S 0.10208	W 0.07421	L.S.D 5%

3- Percentage of potassium in leaves (%)

The results in Table (3) showed that there were significant differences between the control treatment and the salt stress treatments, where control treatment excelled and gave the highest percentage of potassium in the leaves, amounting to 1.89%, followed by the W1 treatment, which gave a percentage of potassium in the leaves amounted to 1.12%, compared with W2, which gave the lowest percentage of potassium in the leaves, amounting to 1.12%. 0.72%, where table shows that there are significant differences in the treatments of spraying nano-elements in trait of the percentage of potassium in the leaves, where Si2 treatment gave the highest rate of potassium in the leaves, which reached 1.43%, compared to the control treatment, which gave the lowest percentage of potassium in the leaves, which amounted to 1.02%. The interaction between salt stress and spraying of nanoparticles, W0Si2 treatment excelled in giving the highest rate of potassium in the leaves, amounting to 2.03%, compared to treatment W2S0, the lowest percentage of potassium in the leaves, amounting to 0.59%.

Table (3): The effect of salt stress and spraying with nano-elements on the percentage of potassium in the leaves of the Egyptian Cassia plant in the spring season 2022-2023 AD (%).

S average	W2	W1	W0	treatment
1.0266	0.5967	0.8733	1.6100	S0
1.2500	0.7600	1.0467	1.9433	Si1
1.4300	0.8300	1.4267	2.0333	Si2
1.1589	0.6667	0.9567	1.8533	SL1
1.3711	0.7900	1.2967	2.0267	SL2
	0.7287	1.1200	1.8933	w average
	S 0.03485	W×S 0.06829	W 0.05472	L.S.D 5%

4- Content of total phenols in leaves ($mg\text{-}g^{-1}$.dry weight)

The results in Table (4) showed that the W2 treatment was superior and gave the highest content of total phenols in the leaves, which amounted to 0.94 $mg\text{-}g^{-1}$.dry weight, followed by the W1 treatment, which gave a content of total phenols in the leaves that amounted to 0.81, while the W0 treatment gave the lowest content of total phenols in the leaves, amounting to 0.75 $mg\text{-}g^{-1}$.dry weight. The control treatment also gave the highest content of total phenols in the leaves, amounting to 0.86 $mg\text{-}g^{-1}$.dry weight, while the SL2 treatment gave the lowest content of total phenols in the leaves, amounting to 0.79 $mg\text{-}g^{-1}$.w. dry.The results also showed that the interaction between salt stress and stress resistance factors had a significant effect on the content of total phenolics in the leaves. The interaction treatment (W2 S0) outperformed significantly and recorded the highest content of total phenolics in the leaves, reaching 0.98 $mg\text{-}g^{-1}$.dry weight, while the The intervention treatment consisting of (liquefied water 1.3 dms^{-1} (W0) Si2) recorded the lowest average content of total phenols in the leaves, which amounted to 0.73 mg-g-1.dry weight.

Table (4): The effect of salt stress and spraying with nano-elements on the content of total phenolics in the leaves of the Egyptian cassia plant in the spring season 2022-2023 AD ($mg\text{-}g^{-1}$.dry weight).

S average	W2	W1	W0	treatment
0.86211	0.97700	0.84067	0.76867	S0
0.82722	0.95300	0.78600	0.74267	Si1
0.78855	0.84533	0.78300	0.73733	Si2
0.85400	0.96667	0.83433	0.76100	SL1
0.83177	0.95233	0.81167	0.73133	SL2
	0.93887	0.81113	0.74820	w average
	S 0.005170	W×S 0.008388	W 0.003608	L.S.D 5%

5- Content of flavonoids ($mg\text{-}gm^{-1}$.dry weight)

The results of Table (5) showed that salt stress had a significant effect on the content of flavonoids (mg-g-1.dry weight). The W2 treatment gave the highest flavonoid content, amounting to 39.50 mg-g-1.dry weight, followed by the W1 treatment and gave the highest flavonoid content. It reached 37.55 $mg\text{-}g^{-1}$ dry weight, while the W0 treatment gave the lowest flavonoid content, amounting to 35.19 $mg\text{-}g^{-1}$ dry weight. The S0 treatment also gave the highest flavonoid content, amounting to 38.33 $mg\text{-}g^{-1}$ dry weight, while the Si1 treatment gave the lowest flavonoid content, amounting to 36.49 $mg\text{-}g^{-1}$ dry weight. The interaction treatment (S0 (W2) was significantly superior and recorded the highest flavonoid content, amounting to 36.49 $mg\text{-}g^{-1}$ dry weight. 40.02 $mg\text{-}g^{-1}$ dry weight, while the W0 Si2 treatment recorded the lowest average flavonoid content of 34.20 $mg\text{-}g^{-1}$ dry weight.

Table (5): The effect of salt stress and spraying with nanoelements on the flavonoid content of the Egyptian Cassia plant in the spring season 2022-2023 ($mg\text{-}g^{-1}$.dry weight).

S average	W2	W1	W0	treatment
38.332	40.020	38.647	36.330	S0
37.398	39.657	37.447	35.090	Si1
36.485	38.727	36.527	34.203	Si2
37.911	39.940	38.073	35.720	SL1
36.9166	39.150	36.980	34.620	SL2
	39.499	37.535	35.193	w average
	S 0.2855	W×S 0.4962	W 0.3108	L.S.D 5%

6- Proline content in leaves (mmol/g fresh weight)

The results of Table (6) showed that salt stress had a significant effect on the proline content in the leaves (mmol/g fresh weight). The W2 treatment gave the highest proline content in the leaves, amounting to 4.18 mmol/g fresh weight, followed by the W1 treatment and gave the proline content in The leaves reached 3.44 mmol/g fresh weight, while the W0 treatment gave the lowest proline content in the leaves, amounting to 2.72 mmol/g fresh weight. The S0 treatment also gave the highest proline content in the leaves, amounting to 3.74 mmol/g fresh weight, while the The SL1 treatment had the lowest proline content in the leaves, reaching 3.30 mmol/g fresh weight. The results also showed that the interaction between salt stress and stress resistance factors had a significant effect on the proline content in the leaves. The W2S0 treatment outperformed and recorded the highest proline content in the leaves, reaching 4.58 mmol/g. Fresh weight, while the S0 W0 S0 treatment recorded the lowest average proline content in the leaves, reaching 3.00 mmol/g fresh weight.

Table (6): The effect of salt stress and spraying with nanoelements on the proline content in the leaves of the Egyptian cassia plant in the spring season 2022-2023 AD (mmol/g fresh weight).

S average	W2	W1	W0	treatment
3.737	4.579	3.629	3.004	S0
3.476	4.121	3.515	2.793	Si1
3.153	3.875	3.136	2.450	Si2
3.564	4.324	3.550	2.820	SL1
3.303	3.989	3.391	2.529	SL2
	4.178	3.444	2.719	w average
	S 0.1129	W×S 0.2598	W 0.2385	L.S.D 5%

The effect of salt stress on the chemical traits of senna plant

In response to salt stress, the formation of proline increases, which works to withdraw the nitrogen necessary to build chlorophyll in favor of proline production [14], Table (6).The formation of proline and soluble sugars increases to resist salt stress by increasing osmosis and decreasing the water potential inside the cells, which leads to the plant needing additional energy to be consumed at the expense of general growth, and this leads to a decrease in the permeability effort and a decrease in dry matter (Garcia-Syvertsen, 2006). These results agreed with Findings by Nikee et al. (2014) in Calendula and Idress et al. (2012) in cultivars of lemongrass and Muhammd and Hussain (2010) in five species of medicinal plants.The formation of proline and soluble sugars increases to resist salt stress by increasing the osmosis and reducing the water potential inside the cells, which leads to the plant needing additional energy to be consumed at the expense of flowering growth, and this leads to a decrease in the osmotic voltage (Garcia-Sanchez and Syvertsen 2006) Table (6). An increase in the absorption of sodium and chloride ions is offset by a decrease in the absorption of phosphorus, magnesium, calcium and potassium, in addition to the effect of salts on the activity of enzymes, especially enzymes related to biological activities and plant metabolism, which is negatively reflected on the division and elongation of plant cells and thus leads to the inhibition of growth indicators for plants [2,39, 24] and this agreed with what was found by [13] when they studied the effect of salt stress on the growth of the daisy plant Caledula officinalis. The decrease in chemical traits also affected the content of plant leaves of nutrients. The concentration of nutrients decreased, as we see that the higher the concentration of salts in the irrigation water, the lower the concentration of nutrients in the leaves. Perhaps the reason for the decrease in the percentage of nitrogen due to the increase in salinity of irrigation water is due to the role of salts in Increasing the osmotic potential of the soil solution and preventing the absorption of nutrients by the plant, or disrupting the nutritional and hormonal balance within the plant [31], or the reason may be due to the effect of the Na+ ion, which works to inhibit the absorption of nitrate and thus reduce the nitrogen content of the leaves, or the reason may be attributed to an increase in the osmotic potential of the soil solution. The percentage of chlorine in the soil solution and its effect on the process of nitrate absorption by seedlings .The decrease in the plant content of nitrogen, phosphorus and potassium (Tables (1,2,3)) that accompanies the increase in irrigation water salinity is due to the effect of high concentrations of Na and Cl in the soil solution, which are absorbed by the plant, which leads to an increase in the osmotic potential of the soil solution, which causes difficulty Absorption of water and ions by plant roots, including potassium, leads to disruption of the cell membrane, inhibition of cell division and expansion, weak growth, and a decrease in the process of carbon synthesis [2]. The decrease may occur due to the effect of salinity on the proteins of the cell membranes, which causes a change in their permeability, in addition to the state of competition that Caused by salinity between chlorine ions Cl¯ and NO3¯, thus reducing potassium [33] The reason for the increase in the content of flower inflorescences of total phenols and flavonoid compounds (Tables (5,6)) under salt stress resulting from the salinity of irrigation water is that salinity stimulates their production as one of the mechanisms to neutralize active oxygen radicals, that is, they are considered a defense mechanism for the plant [17 . This is consistent with the findings of Al-Mamouri (2018) on Petunias and Cha-um) and Kirdmanee, 2009) on dwarf roses, [1] on dwarf roses.

Effect of spraying nanoparticles on the chemical traits of Cassia acutifolia

Silicon enhances the adaptive capacity of plants under salinity conditions. Studies show that the use of silicon stimulates the accumulation of beneficial chemical compounds in plant tissues, such as anthocyanins, flavonoids, and phytosterols. These chemical compounds act as antioxidants and anti-inflammatory agents, helping to protect plants from the effects of salt stress and reduce damage [4].Some studies indicate that the use of silicon can improve plant uptake of essential nutrients such as nitrogen, phosphorous, and potassium. Silicon is a beneficial element for plants and can enhance plants' resilience and resistance to environmental stresses, including salt stress. Silicon is believed to help activate plant response mechanisms to salt tolerance and improve nutrient uptake by enhancing root activity and improving plant structure [10], thus the use of silicon could contribute to increasing the content of nitrogen, phosphorus and potassium in the leaves of plants under stress. brine. This, in turn, can help promote the healthy growth of plants and increase their resistance to harsh conditions. Regarding the effect of silicon on the content of phenols and flavonoids, a study on rice plants found that the use of silicon led to an increase in the accumulation of phenols and flavonoids in flowers, thus increasing the content of beneficial plant compounds [16] . In general, phenols and flavonoids are secondary compounds that protect plants from environmental stresses and biotic threats, and research has shown that increased accumulation of these compounds can enhance plant resistance to salt stress. Silicon may help promote this resistance by activating plant defense mechanisms and stimulating the production of phenols and flavonoids (Mahmoud et al., 2020).Also, selenium significantly affects the increase of nutrients in the leaves, where the reason is due to its role in increasing the vegetative growth rate and leafy area, which improves the growth of the root system and then increases the area of absorption of the nutrients nitrogen, phosphorus and potassium in the growth medium [3,18].

References

1. Abbas, Jamal Ahmed, Mansour Abd Abu Hana, and Nibras Ihsan Abdul-Jabbar (2010) Effect of irrigation of dwarf rose plants with water of different salinities and potassium fertilization on the growth and flowering characteristics of Miniature rosesL.. Al-Furat Journal of Agricultural Sciences.2 (3): 61-70.

2. Abbaspour, H., Afshari, H., Fallahyan, F., & Fahimi, H. (2006). Response of Pistacia vera L. in salt tolerance to inoculation with arbuscular mycorrhizal fungi under salt stress. Acta horticulturae, 726, 383.

3. Abul-Soud, M., & Abd-Elrahman, S. (2016). Foliar selenium application to improve the tolerance of eggplant grown under salt stress conditions. International Journal of Plant & Soil Science, 9(1), 1-10.

4. Ahmed, F.F., Mohamed, Y. and Abdalla, B.M., (2007). The relation between using some antioxidants and productivity of "Sewy" date palm. Minia Journal of Agricultural Research and Development. 27(4): 753-770.

5. Al-Amiri, Maytham Mohsen, Sanaria Abbas, and Liqaa Jazea. 2009. A study of the phenotypic characteristics of the senna plant and the effect of alcoholic and hot aqueous extracts on the growth of selected types of bacteria and yeasts. Iraqi Journal of Market Research and Consumer Protection, 1(1): 19-40.

6. Al-Asadi, Maher Hamid Salman (2018) The basics of medicinal plants and their effective compounds. Al Qasim Green University. Ministry of Higher Education and Scientific Research. Iraq.

7. Al-Hilal, Ali Abdul Mohsen (1420 AH), Plant Physiology under Drought and Salt Stress, Deanship of Library Affairs, King Saud University, Riyadh.

8. Al-Mawsili, Ahmed Daoud and Sahl Kawkab Ali Al-Jamil. 2019. Insect repellent plants. Dar Al-Kutub Al-Ilmiyyah, Beirut, Lebanon.

9. Al-Rawi, Khashi Mahmoud Abdel Aziz Muhammad and Khalaf Allah. 2000. Design and analysis of agricultural experiments. College of Agriculture and Forestry. University of Al Mosul. The Republic of Iraq.

10. Asgari, F., & Diyanat, M. (2021). Effects of silicon on some morphological and physiological traits of rose (Rosa chinensis var. minima) plants grown under salinity stress. Journal of Plant Nutrition, 44(4), 536-549.

11. Barker, A, V., and Pilbeam, D.J. (2015). Handbook of plant Nutrition. CRC Press. ISBN:9781439881989.

12. Bates, S. L.; Waldern, R. and Teare, I.D. (1973). Rapid determination of free prolin for water stress studies planet and soil, 39(1): 205-207.

13. Bayat, S., Porra, L., Suhonen, H., Nemoz, C., Suortti, P., & Sovijarvi, A. R. (2006). Differences in the time course of proximal and distal airway response to inhaled histamine studied by synchrotron radiation CT. Journal of Applied Physiology, 100(6), 1964-1973.

14. Cha-um, S. and Kirdmanee, C. (2009). Effect of salt stress on proline accumulation, photosynthetic ability and growth characters in two maize cultivars. Pakistan Journal of Botany. 41: 87–98.

15. Constan, D.; Patel, R.; Keegstra, K., &amp and Jarvis, P. (2004). An outer envelope membrane component of the

plastid protein import apparatus plays an essential role inarabidopsis. The Plant Journal. 38(1): 93–106.

16. Dhiman, P., Rajora, N., Bhardwaj, S., Sudhakaran, S. S., Kumar, A., Raturi, G., ... & Deshmukh, R. (2021). Fascinating role of silicon to combat salinity stress in plants: An updated overview. Plant Physiology and Biochemistry, 162, 110-123.
17. Ebrahimian, E., & Bybordi, A. (2012). Effect of salinity, salicylic acid, silicium and ascorbic acid on lipid peroxidation, antioxidant enzyme activity and fatty acid content of sunflower. African Journal of Agricultural Research, 7(25), 3685-3694.
18. Elizabethn, A.H.; Pilon-Smits and Colin, F.Q. (2010). Selenium Metabolism in plants: R. Hell and R.-R. Mendel (eds.), Cell Biology of Metals and Nutrients. Springer-Verlag Berlin Heidelberg.
19. Garcia-Sanchez, F., & Syvertsen, J. P. (2006). Environmental Stress Physiology-Salinity Tolerance of Cleopatra Mandarin and Carrizo Citrange Rootstock Seedlings Is Affected by CO2 Enrichment during Growth. Journal of the American Society for Horticultural Science, 131(1), 24-31
20. García-Sánchez, I. M. (2006). Efficiency measurement in Spanish local government: the case of municipal water services. Review of Policy Research, 23(2), 355-372.
21. Hazen, S.P.; Wu, Y. and Kreps, J.A. (2003). Gene expression profiling of plant responses to abiotic stress. Functional & Integrative Genomics. 3(3): 105–111.
22. Idrees, M., Naeem, M., Khan, M. N., Aftab, T., Khan, M. M. A., & Moinuddin. (2012). Alleviation of salt stress in lemongrass by salicylic acid. Protoplasma, 249, 709-720
23. Jackson, M.L. (1958). Soil chemical analysis prentice. Hall & Englewood, Cliffs, N. T. USA.
24. Khavari-Nejad, R. A., Bujar, M., & Attaran, E. (2006). Evaluation Of Anthocyanin Contents Under Salinity (Nacl) Stress In Bellis Perennis L. Ecophysiology of high salinity tolerant plants, 127-134.
25. Liu, H.; Yang, W.; Liu, D.; Han, Y.; Zhang, A. and Li, S. (2011). Ectopic expression of a grapevine transcription factor VvWRKY11 contributes to osmotic stress tolerance in Arabidopsis. Molecular Biology Reports. 38(1): 417–427.
26. Mahmoud, A. D., Labaran, I., & Yunusa, A. (2020). Ethnobotany of medicinal plants with antimalarial potential in Northern Nigeria. Ethnobotany Research and Applications, 19, 1-8.
27. Mohamed, S. M., Hassan, E. M., & Ibrahim, N. A. (2010). Cytotoxic and antiviral activities of aporphine alkaloids of Magnolia grandiflora L. Natural Product Research, 24(15), 1395-1402.
28. Niki, E. (2014). Role of vitamin E as a lipid-soluble peroxyl radical scavenger: in vitro and in vivo evidence. Free Radical Biology and Medicine, 66, 3-12.
29. Nille, G.C. and Reddy, K.R., (2015). A phytopharmacological review of plant–Cassia auriculata. International Journal of Pharmaceutical and Biological Archives. 6(6): 1-9.
30. Pal, A.; Shirodkar, S.N.; Gohil, S.; Ghosh, S.; Waghmare, U.V. and Ayyub, P. (2013). Multiferroic Behavior in Elemental Selenium below 40 K: Effect of Electronic Topology. Scientific Reports, 3(1).

31. Parihar, P.; Singh, S.; Singh, R.; Singh, V.P. and Prasad, S.M. (2015). Effect of salinity stress on plants and its tolerance strategies: a review. Environmental Science and Pollution Research. 22(6): 4056–4075.

32. Porra, R.J.; Thompson, W.A. and Kriedemann, P.E. (1989). Determination of Accurate Extinction Coefficients and Simultaneous Equations for Assaying Chlorophylls a and b Extracted with Four Different Solvents: Verification of the Concentration of Chlorophyll Standards by Atomic Absorption Spectroscopy. Biochimica et Biophysica Acta. 975: 384-394.

33. Ramoliya, P. J., Patel, H. M., Joshi, J. B., & Pandey, A. N. (2006). Effect of salinization of soil on growth and nutrient accumulation in seedlings of Prosopis cineraria. Journal of Plant Nutrition, 29(2), 283-303.

34. Taiz, L. and Zeiger, E. (2002) Plant Physiology. 3rd Edition, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

35. Vlas, J. and Vlas-de Jong, J. (2008). Illustrated field guide to the flowers of Sri Lanka. Mark Booksellers and Distributors (Pvt) Ltd., Kandy, Sri Lanka, pp. 139–141. ISBN: 9789082313406

36. Wang, M.; Zheng, Q.; Shen, Q. and Guo, S. (2013). The Critical Role of Potassium in Plant Stress Response. International Journal of Molecular Sciences. 14(4): 7370–7390.

37. White, R. M., & Koehler, R. (1972). Magnetic susceptibility of crystalline and amorphous selenium. The Philosophical Magazine, 26(3), 757–760.

38. Yoshida, S.; Navasero, S.A. and Ramirez, E.A. (1962). Effects of silica and nitrogen supply on some leaf characters of the rice plant. Plant and Soil. 31(1): 48–56.

39. Younis, A. ,Riaz, A., , Hameed, M., & Kiran, S. (2010). Morphological and biochemical responses of turf grasses to water deficit conditions. Pak. J. Bot, 42(5), 3441-3448.

ISSN 2072-3857