# Effect of some antioxidants on the growth of Senna coffee plant (Cassia occidentalis) growing under the influence of salt stress

**Bayader Abd Aljabar Ali Janan K. Hussein**

**College of Agriculture, Al-Qasim Green University, Babylon province, Iraq.**

**ABSTRACT**

The field experiment was conducted in the Saran-covered canopy belonging to Agricultural Preparatory School, Abi Gharq for the spring season (2018-2017) to study the effect of antioxidants (Vitamin E, salicylic acid and selenium) on the tolerance of the Senna coffee plant to salt stress. The seeds of Senna coffee was obtained from a plant grown in a home garden in Baghdad. The study was conducted to study the effect of saline stress at two levels of well water (4, 8 $dS.m^{-1}$), in addition to the water of control treatment (Tap water) and spraying three factors of antioxidant (200 $mg.L^{-1}$ salicylic acid and 150 $mg.L^{-1}$ vitamin E and 173 $mg.L^{-1}$ selenium) as well as the control treatment of and interactions between factors in the growth and flowering of the Senna coffee plant and its content of active compounds. It was observed that irrigating with well water at a salinity of (4, 8 $dS.m^{-1}$) led to a significant decrease in all the vegetative and flowering traits for the Senna coffee plant. The spraying with selenium, vitamin E and salicylic acid was significantly affected in improving the most studied traits of Senna coffee plants.

*Research paper from MSc thesis for the first author

## تأثير بعض مضادات الاكسدة في نمو نبات السنا *Cassia occidentalis* النامي تحت تأثير الاجهاد الملحي

**بيادر عبد الجبار علي جَنان قاسم حسين**

**كلية الزراعة, جامعة القاسم الخضراء, محافظة بابل, العراق.**

**الخلاصة:**

نفذت التجربة في الضلة المغطاة بالساران التابعة لإعدادية الزراعة /ابي غرق للموسم الربيعي2017-2018 لدراسة تأثير مضادات الاكسدة ( فيتامين E وحامض السالساليك والسلينيوم) في تحمل نبات السنا للإجهاد الملحي , تم الحصول على بذور سنا القهوة من نبات مزروع في احدى الحدائق المنزلية في بغداد, نفذت الدراسة المتكونة من تجربه حقليه لدراسة تأثير الاجهاد الملحي بمستويين من ماء البئر ( 4 ديسمينز.م$^{-1}$ و 8 ديسمينز.م$^{-1}$ ) فضلا عن معاملة القياس (ماء اسالة ) ورش ثلاثة عوامل من مضادات الاكسدة ( حامض السالسيلك200 ملغم.لتر$^{-1}$ و فيتامين 150E ملغم .لتر$^{-1}$ والسيلينيوم 173 ملغم.لتر$^{-1}$) فضلا عن معاملة القياس والتداخل بين العوامل في نمو وازهار نبات السنا ومحتواه من المركبات الفعالة. لوحظ ان السقي بماء بئر ملوحة 4 ديسمينز.م$^{-1}$ وماء بئر 8 ديسمينز.م$^{-1}$ أدى الى حصول انخفاض معنوي في جميع الصفات الخضرية والزهرية لنبات السنا. اثر الرش بكل من السيلينيوم وفيتامين E وحامض السالسيلك معنويا في تحسين اغلب الصفات المدروسة لنبات السنا .

البحث مستل من رسالة ماجستير للباحث الاول

## 1. INTRODUCTION

Senna coffee plant (Cassia occidentalis) belongs to the Fabaceae family. The Cassia genus contains about 500 species, most of which are used for medicinal purposes or to decorate streets and parks for the beauty of their abundant yellow flowers. Senna leaves, fruits, and roots contain Anthraquinone glycosides and their derivatives consisting of Aloe-emodin and Rhein (resins), both in free or bound form and together form different glycoside forms. Commercially sold leaves contain 2-3% glycoside A and B together and 2-4% of glycoside C. Senna leaves and fruits also contain resinous materials, which are attributed to the mild colic that accompanies the work of the Senna. in general, the Senna is used as a stimulant for the muscle layer of the intestinal wall, so it is used as a laxative, and the Senna is

 ISSN 2072-3875

considered one of the preferred laxatives for treating chronic constipation. Senna differs from other plants such as castor and patience in its effect to reduce headache or stomach ache when used (3). Salinity is a major and important problem facing the agricultural sector for areas exposed to a lack of irrigation water suitable for agricultural irrigation, where it is a key factor in converting fertile and productive lands to deserts and it leads to a change in the biological diversity of natural plants, so they are a reason to reduce the growth and yield of the growing plant in those soils due to their effects on Reducing the plant's ability to absorb water and nutrients from the soil solution and increasing toxicity due to the high concentrations of some ions, inhibiting the process of cell expansion, influencing the process of carbon metabolism, building proteins, energy production, inhibiting metabolism, and production of reactive oxygen species (ROS), as well as inhibiting the effectiveness of enzymes, imbalance and hormonal balance for the plant, especially when exposed to high concentrations of salts (25). Due to the scarcity of presence an applied study in Iraq on improving the phenotypic traits for the local Senna plant and its tolerance to stresses, the study aims to:

1- Evaluating the tolerance of the senna plant to salt stress.
2- The extent of the contribution of antioxidants (salicylic acid, vitamin E, selenium) in reducing the salinity of irrigation water and dehydration and improving the growth and flowering of the Senna plant.

## 2. MATERIALS AND METHODS

The field experiment was conducted in the Saran-covered canopy belonging to Agricultural Preparatory School, Abi Gharq for the spring season (2018-2017) to study the effect of antioxidants (Vitamin E, salicylic acid and selenium) on the tolerance of the Senna coffee plant to salt stress. The seeds of Senna coffee was obtained from a plant grown in a home garden in Baghdad. The seeds were cultivated on 3/15/2018 in a bags filled with the riverine mixture, and after the plant reached two pairs of real leaves, the plants were transferred to pots with a diameter of 32 cm containing a soil media consisting of 2: 1: 1 riverine mixture, peat moss, and decomposed organic fertilizer, respectively.

**Study implementation:**

The experiment was conducted to study the effect of salt stress on the growth and flowering of the Senna plant according to the following treatments:

**The first factor: salt stress**

Plants were irrigated with three salt concentrations depending on well water, as follows:

1- The control treatment (Tap water 1.1 $dS.m^{-1}$), which is symbolized by (S0).
2- Water well with a concentration of (4 $dS.m^{-1}$), which is symbolized by (S1).
3- Water well with a concentration of (8 $dS.m^{-1}$), which is symbolized by (S2).

**The second factor: antioxidants**

A group of factors was used to help minimize the damage of salt stress on the plant, where it sprayed on the plants every 20 days and between one factor and another is 3 days, at the rate of four sprayings throughout the study period, as follows:

1- The control treatment (sprayed with distilled water), which is symbolized by (A0).
2- Salicylic acid at a concentration of (200 $mg.L^{-1}$), which is symbolized by (A1).
3- Salicylic acid at a concentration of (150 $mg.L^{-1}$), which is symbolized by (A2).
4- Salicylic acid at a concentration of (173 $mg.L^{-1}$), which is symbolized by (A3).

The experiment was conducted as a factorial experiment (3x4) within the Complete

Randomized Block Design (R.C.B.D) and with three replicates, thus each replicate contained 12 treatments with a rate of six plants per experimental unit and the averages were compared according to the Duncan's New Multiple Range Test (1).

## 3. RESULTS AND DISCUSSION

### The traits of vegetative growth:

### plant Height (cm):

Table (1) shows that there were no significant differences for irrigating with different concentrations of well water in the height of senna plants, while the spraying with salicylic acid and vitamin E were characterized by their highest plant height amounted to (171.33 and 162.11 cm), respectively, with a significant difference from the control treatment which amounted to (135.55 cm). As for the interaction between the factors of the experiment, it was observed the superiority of the S0A1 treatment by giving it the highest plant height amounted to (186 cm), without a significant difference from the treatments (S2A1, S1A3, S1A2, S1A1, S0A2), while the lowest plant height was at the interaction treatment (S1A0) which amounted to (131.67 cm).

**Table 1:** Effect of salt stress on the height of the Senna plant (cm)

| Salt stress ($dS.m^{-1}$) (S) | Stress resistance (A) ($mg.L^{-1}$) | | | | Average (S) |
|---|---|---|---|---|---|
| | Distilled water (A0) | Salicylic 200 (A1) | Vitamin E 150 (A2) | Selenium 173 (A3) | |
| Tap Water (1.1 $dS.m^{-1}$) (S0) | 136.67 BC | 186.00 A | 183.33 A | 139.00 BC | 161.25 A |
| Well water (4 $dS.m^{-1}$) (S1) | 131.67 C | 159.33 ABC | 166.33 AB | 155.00 ABC | 153.08 A |
| Water well (8 $dS.m^{-1}$) (S2) | 138.33 BC | 168.67 AB | 136.67 C | 150.00 BC | 148.41 A |
| Average (A) | 135.55 C | 171.33 A | 162.11 AB | 148.00 BC | |

### The number of main branches ($branch.plant^{-1}$):

Table (2) shows that there were significant differences for irrigating with different concentrations of well water in the number of main branches for Senna plants, where the irrigating with Tap water gave the highest number of branches amounted to (4.83 $branches.plant^{-1}$), with a significant difference from irrigating with the well water at a salinity of (4, 8 $dS.m^{-1}$). While spraying with selenium was characterized by giving it the highest number of main branches on the plant amounted to (5.77 $branches.plant^{-1}$), which was characterized by a significant difference from the rest of the treatments. As for the control treatment, It gave the lowest number of branches on the plant amounted to (2.33 $branches.plant^{-1}$). As for the interaction between the factors of the experiment, it was observed the superiority of the S0A3 treatment in the number of branches on the plant, without a significant difference from the treatments (S1A2, S1A1, and S1A3), while the lowest number of branches on the plant was at the interaction treatment (S1A0) which amounted to (1.00 $branches.plant^{-1}$).

**Table 2:** Effect of salt stress on the number of main branches for Senna plants (branches.plant$^{-1}$)

| **Salt stress (dS.m$^{-1}$) (S)** | **Stress resistance (A) (mg.L$^{-1}$)** | | | | **Average (S)** |
|---|---|---|---|---|---|
| | **Distilled water (A0)** | **Salicylic 200 (A1)** | **Vitamin E 150 (A2)** | **Selenium 173 (A3)** | |
| Tap Water (1.1 dS.m$^{-1}$) (S0) | 3.66 CDE | 4.00 BCD | 5.33 AB | 6.33 A | 4.83 A |
| Well water (4 dS.m$^{-1}$) (S1) | 1.00 G | 5.33 AB | 3.00 DEF | 5.00 ABC | 3.58 B |
| Water well (8 dS.m$^{-1}$) (S2) | 2.33 EFG | 2.00 FG | 4.00 BCD | 6.00 A | 3.58 B |
| Average (A) | 2.33 C | 3.77 B | 4.11 B | 5.77 A | |

**The diameter of the main stem (mm):**

Table (3) shows that there were no significant differences for irrigating with different concentrations of well water in the diameter of the main stem for Senna plants. The spraying treatments and interaction between two factors did not give any significant differences in the diameter of the main stem for the senna plant .

**Table 3:** Effect of salt stress on the diameter of the main stem for Senna plants (mm)

| **Salt stress (dS.m$^{-1}$) (S)** | **Stress resistance (A) (mg.L$^{-1}$)** | | | | **Average (S)** |
|---|---|---|---|---|---|
| | **Distilled water (A0)** | **Salicylic 200 (A1)** | **Vitamin E 150 (A2)** | **Selenium 173 (A3)** | |
| Tap Water (1.1 dS.m$^{-1}$) (S0) | 1.16 A | 1.26 A | 1.26 A | 1.30 A | 1.25 A |
| Well water (4 dS.m$^{-1}$) (S1) | 1.03 A | 1.09 A | 1.30 A | 1.33 A | 1.19 A |
| Water well (8 dS.m$^{-1}$) (S2) | 0.90 A | 1.16 A | 1.33 A | 0.90 A | 1.07 A |
| Average (A) | 1.03 A | 1.17 A | 1.30 A | 1.17 A | |

**Percentage of dry matter in leaves (%)**

Table (4) shows that there were no significant differences for irrigating with different concentrations of well water in the percentage of dry matter in leaves for senna plants. The spraying treatments and interaction between two factors did not give any significant differences in the percentage of dry matter in leaves for the senna plant. As for the interaction between the factors of the experiment, it was observed the superiority of the S0A2 treatment in the percentage of dry matter in leaves for senna plants, without significant difference from the rest of the treatments.


ISSN 2072-3875

**Table 4:** Effect of salt stress on the percentage of dry matter in leaves for senna plants (%)

| Salt stress ($dS.m^{-1}$) (S) | Stress resistance (A) ($mg.L^{-1}$) | | | | Average (S) |
|---|---|---|---|---|---|
| | Distilled water (A0) | Salicylic 200 (A1) | Vitamin E 150 (A2) | Selenium 173 (A3) | |
| Tap Water (1.1 $dS.m^{-1}$) (S0) | 46.24 A | 49.84 A | 52.68 A | 48.91 A | 49.41 A |
| Well water (4 $dS.m^{-1}$) (S1) | 46.97 A | 48.31 A | 44.37 A | 43.44 A | 45.77 A |
| Water well (8 $dS.m^{-1}$) (S2) | 46.24 A | 47.72 A | 46.79 A | 44.41 A | 46.40 A |
| Average (A) | 46.63 A | 48.2 A | 47.94 A | 45.59 A | |

**The traits of Flower growth:**

**The number of days required to open the first flower (day):**

Table (5) shows that there were significant differences for irrigation with different concentrations of well water in the number of days required to open the first flower for Senna plants, where irrigating treatments with well water (4 and 8 $dS.m^{-1}$) were characterized by giving them the lowest number of days required to open the first flower on the plant amounted to (77.16 days and 76.25 days), with a significant difference from the control treatment, which gave the highest number of days required to open the first flower on the plant. While the spraying treatment (with vitamin E and selenium) was characterized by giving them the lowest number of days required to open the first flower on the plant amounted to (77.11 and 77.66 days). As for the interaction between the factors of the experiment, it was observed the superiority of the S2A3 treatment by giving it the lowest number of days required to open the first flower on the plant amounted to (67.33 days), without a significant difference from the treatments (S1A3, S1A2, S1A1, and S2A2), while the highest number of days required to open the first flower on the plant was at interaction treatment (S0A0) which amounted to (103 days) and without a significant difference from treatments (S0A1 and S0A3).

**Table 5:** Effect of salt stress on the number of days required to open the first flower for Senna plants (day)

| Salt stress ($dS.m^{-1}$) (S) | Stress resistance (A) ($mg.L^{-1}$) | | | | Average (S) |
|---|---|---|---|---|---|
| | Distilled water (A0) | Salicylic 200 (A1) | Vitamin E 150 (A2) | Selenium 173 (A3) | |
| Tap Water (1.1 $dS.m^{-1}$) (S0) | 103 A | 97.00 AB | 93.33 B | 94.66 AB | 97.16 A |
| Well water (4 $dS.m^{-1}$) (S1) | 93.33 B | 75.33 DE | 71.00 DE | 69.33 DE | 77.16 B |
| Water well (8 $dS.m^{-1}$) (S2) | 89.33 BC | 79.33 CD | 69.00 E | 67.33 E | 76.25 B |
| Average (A) | 95.33 A | 83.88 B | 77.77 C | 77.11 C | |


ISSN 2072-3875

**Number of inflorescences (inflorescences.plant$^{-1}$)**

Table (6) shows that there were significant differences for irrigating with different concentrations of well water in the number of inflorescences for Senna plants, where the irrigating with Tap water gave the highest number of inflorescences which amounted to (73.83 inflorescences.plant$^{-1}$), with a significant difference from the irrigation treatment with well water (8, 4 dS.m$^{-1}$) which amounted to (50.50 and 48.41 inflorescences.plant$^{-1}$). While the spraying with selenium and vitamin E was characterized by giving them the highest number of inflorescences on the plant amounted to (81.22 and 72.88 inflorescences.plant$^{-1}$) compared to the control treatment that gave the lowest number of inflorescences on the plant amounted to (25.22 inflorescences.plant$^{-1}$). As for the interaction between the factors of the experiment, it was observed the superiority of the S0A3 treatment by giving it the highest number of inflorescences on the plant amounted to (115.66 inflorescences.plant$^{-1}$), with a significant difference from the rest of the treatments, while the lowest number of inflorescences on the plant was at interaction treatment (S2A0) which amounted to (17.66 inflorescences.plant$^{-1}$).

**Table 6:** Effect of salt stress on the number of inflorescences for Senna plants (inflorescences.plant$^{-1}$)

| Salt stress (dS.m$^{-1}$) (S) | Stress resistance (A) (mg.L$^{-1}$) | | | | Average (S) |
|---|---|---|---|---|---|
| | **Distilled water (A0)** | **Salicylic 200 (A1)** | **Vitamin E 150 (A2)** | **Selenium 173 (A3)** | |
| Tap Water (1.1 dS.m$^{-1}$) (S0) | 27.33 EF | 60.34 CD | 89.98 B | 115.66 A | 73.33 A |
| Well water (4 dS.m$^{-1}$) (S1) | 30.62 EF | 38.15 E | 74.60 BC | 52.54 D | 48.97 B |
| Water well (8 dS.m$^{-1}$) (S2) | 16.61 F | 54.33 D | 57.43 D | 70.12 CD | 49.62 B |
| Average (A) | 24.85 C | 50.94 B | 72.88 A | 79.22 A | |

**Seed traits:**

**The number of pods (pod.plant$^{-1}$):**

Table (7) shows that there are significant differences for irrigating with different concentrations of well water in the number of pods for Senna plants, where the irrigating with Tap water gave the highest number of pods which amounted to (71.16 pod.plant$^{-1}$), with a significant difference from the irrigation treatment with well water (4 and 8 dS.m$^{-1}$) which amounted to (50 .50 and 49.91 pod.plant$^{-1}$), respectively. While the spraying with selenium and vitamin E was characterized by giving them the highest number of pods on the plant amounted to (77.66 and 72.88 pods.plant$^{-1}$), respectively, with a significant difference from the control treatment which amounted to (25.22 pods.plant$^{-1}$). As for the interaction between the factors of a salt stress experiment, it was observed the superiority of the S0A3 treatment on the rest of the treatments, while the lowest number of pods per plant was at the interaction treatment (S2A0) which amounted to (17.66 pods.plant$^{-1}$).


ISSN 2072-3875

**Table 7:** Effect of salt stress on the number of pods for Senna plants (pods.plant$^{-1}$)

| Salt stress (dS.m$^{-1}$) (S) | Stress resistance (A) (mg.L$^{-1}$) | | | | Average (S) |
|---|---|---|---|---|---|
| | Distilled water (A0) | Salicylic 200 (A1) | Vitamin E 150 (A2) | Selenium 173 (A3) | |
| Tap Water (1.1 dS.m$^{-1}$) (S0) | 29.33 FG | 62.66 DE | 87.66 BC | 105 A | 71.16 A |
| Well water (4 dS.m$^{-1}$) (S1) | 28.66 FG | 35.00 F | 78.66 B | 59.66 DE | 50.50 B |
| Water well (8 dS.m$^{-1}$) (S2) | 17.66 G | 61.33 DE | 52.33 E | 68.33 CD | 49.91 B |
| Average (A) | 25.22 C | 53.00 B | 72.88 A | 77.66 A | |

**The number of seeds (seed.pod$^{-1}$):**

Table (8) shows that there were significant differences for irrigating with different concentrations of well water in the number of seeds on the pod for Senna plants, where the irrigating with Tap water and well water (4 dS.m$^{-1}$) gave the highest number of seeds, which amounted to (39.16 and 39.08 seeds.pod$^{-1}$), with a significant difference compared to the irrigation with well water (8 dS.m$^{-1}$) which amounted to (34.75 seed.pod$^{-1}$). While spraying with selenium was characterized by giving it the highest number of seeds in the pod amounted to (47.22 seeds.pod$^{-1}$). As for the control treatment, it gave the lowest number of seeds in the pod amounted to (28.00 seeds.pod$^{-1}$). As for the interaction between the factors of the experiment, it was observed the superiority of the S0A3 treatment by giving it the highest number of seeds in the pod, without a significant difference from the S1A3 treatment while the lowest number of seeds in the pod was at the interaction treatment (S2A0) which amounted to (25.66 seeds.pod$^{-1}$).

**Table 8:** Effect of salt stress on the number of seeds on the pod for Senna plants (seeds.pod$^{-1}$)

| Salt stress (dS.m$^{-1}$) (S) | Stress resistance (A) (mg.L$^{-1}$) | | | | Average (S) |
|---|---|---|---|---|---|
| | Distilled water (A0) | Salicylic 200 (A1) | Vitamin E 150 (A2) | Selenium 173 (A3) | |
| Tap Water (1.1 dS.m$^{-1}$) (S0) | 28.66 GH | 36.00 DE | 40.66 BC | 51.33 A | 39.16 A |
| Well water (4 dS.m$^{-1}$) (S1) | 29.66 FG | 35.66 DE | 42.66 B | 48.33 A | 39.08 A |
| Water well (8 dS.m$^{-1}$) (S2) | 25.66 H | 33.33 EF | 38.00 CD | 42.00 B | 34.75 B |
| Average (A) | 28.00 D | 35.00 C | 40.44 B | 47.22 A | |

**Weight 100 seeds (g):**

Table (9) shows that there were significant differences for irrigating with different concentrations of well water in the weight 100 seeds, where the irrigating with well water (4 dS.m$^{-1}$) and Tap water gave the highest weight of 100 seeds on the plant Senna, which amounted to (1.47 g and 1.46 g), respectively, which differed significantly from the lowest weight amounted to (1.40 g) at the irrigating


ISSN 2072-3875

with well water (8 $dS.m^{-1}$). While spraying with vitamin E was characterized by giving it the highest weight amounted to (1.54 g), which was characterized from the rest of the treatments, while spraying with salicylic acid gave the lowest seed weight amounted to (1.36 g). As for the interaction between the factors of the experiment, it was observed the superiority of the S0A2 treatment by giving it the highest seed weight, without significant difference from the treatments (S1A2 and S1A0), while the S2A0 treatment gave the lowest seed weight amounted to (1.30 g).

**Table 9:** Effect of salt stress on the weight of 100 seeds for Senna plants (g)

| **Salt stress ($dS.m^{-1}$) (S)** | **Stress resistance (A) ($mg.L^{-1}$)** | | | | **Average (S)** |
|---|---|---|---|---|---|
| | **Distilled water (A0)** | **Salicylic 200 (A1)** | **Vitamin E 150 (A2)** | **Selenium 173 (A3)** | |
| Tap Water (1.1 $dS.m^{-1}$) (S0) | 1.47 B | 1.32 D | 1.58 A | 1.47 B | 1.46 A |
| Well water (4 $dS.m^{-1}$) (S1) | 1.57 A | 1.32 D | 1.57 A | 1.43 BC | 1.47 A |
| Water well (8 $dS.m^{-1}$) (S2) | 1.30 D | 1.45 B | 1.48 B | 1.39 C | 1.40 B |
| Average (A) | 1.45 B | 1.36 C | 1.54 A | 1.43 B | |

**Estimating total sugars in senna leaves ($mg.g^{-1}$)**

Table (10) shows that there were significant differences for irrigating with different concentrations of well water in the total sugars in the leaves of the Senna plant where the irrigating with well water (8, 4 $dS.m^{-1}$) was characterized by giving them the highest concentration of total sugars in the leaves amounted to (26.81 and 26. 61 $mg.g^{-1}$) compared to the lowest concentration when watering with Tap water amounted to (19.49 $mg.g^{-1}$). While spraying with vitamin E was characterized by giving it the highest concentration of total sugars in the leaves amounted to (27.30 $mg.g^{-1}$). As for the control treatment, it gave the lowest concentration amounted to (19.57 $mg.g^{-1}$). As for the interaction between the factors of the salt stress experiment, it was observed the superiority of the S1A1 treatment in the concentration of total sugars in the leaves amounted to (44.86 $mg.g^{-1}$). While the lowest percentage of sugars was at the interaction treatment (S0A1), which amounted to (12.48 $mg.g^{-1}$).

**Table 10:** Effect of salt stress on the total sugars in the leaves of the Senna plant ($mg.g^{-1}$)

| **Salt stress ($dS.m^{-1}$) (S)** | **Stress resistance (A) ($mg.L^{-1}$)** | | | | **Average (S)** |
|---|---|---|---|---|---|
| | **Distilled water (A0)** | **Salicylic 200 (A1)** | **Vitamin E 150 (A2)** | **Selenium 173 (A3)** | |
| Tap Water (1.1 $dS.m^{-1}$) (S0) | 16.95 DE | 12.48 E | 30.26 BC | 18.25 D | 19.49 B |
| Well water (4 $dS.m^{-1}$) (S1) | 14.90 DE | 44.86 A | 23.97 C | 22.71 CD | 26.61 A |
| Water well (8 $dS.m^{-1}$) (S2) | 26.87 C | 19.46 D | 27.66 C | 33.24 B | 26.81 A |
| Average (A) | 19.57 B | 25.60 A | 27.30 A | 24.73 A | |

 ISSN 2072-3875

### Estimating Total Antioxidants in Senna Leaves (μmol.$g^{-1}$)

Table (11) shows that there were significant differences for irrigating with different concentrations of well water in the total antioxidants of the leaves for the Senna plant where the irrigating with well water (8 dS.$m^{-1}$) was characterized by giving it the highest concentration of the total antioxidant in the leaves amounted to (152.13 μmol.$g^{-1}$) compared to the lowest concentration when irrigation with Tap water which amounted to (87.01 μmol.$g^{-1}$). While spraying with salicylic acid, vitamin E and selenium was characterized by giving them the highest concentration of total antioxidant in the leaves amounted to (129.01, 126.24 and 126.24 μmol.$g^{-1}$), respectively. As for the interaction between the factors of the experiment, it was observed the superiority of the S2A2 treatment in the total antioxidants in the leaves amounted to (163.85 μmol.$g^{-1}$), which did not differ significantly from the S2A1treatment, while the lowest concentration of the total antioxidants was at the interaction treatment (S0A0) which amounted to (64.30 μmol.$g^{-1}$).

**Table 11:** Effect of salt stress on the total antioxidants in the leaves for the Senna plant (μmol.$g^{-1}$)

| Salt stress (dS.$m^{-1}$) (S) | Stress resistance (A) (mg.$L^{-1}$) | | | | Average (S) |
|---|---|---|---|---|---|
| | Distilled water (A0) | Salicylic 200 (A1) | Vitamin E 150 (A2) | Selenium 173 (A3) | |
| Tap Water (1.1 dS.$m^{-1}$) (S0) | 64.30 H | 104.54 E | 84.21 G | 94.99 F | 87.01 C |
| Well water (4 dS.$m^{-1}$) (S1) | 140.21 B | 121.54 D | 130.67 C | 138.13 B | 132.64 B |
| Water well (8 dS.$m^{-1}$) (S2) | 138.13 B | 160.95 A | 163.85 A | 145.60 B | 152.13 A |
| Average (A) | 114.21 B | 129.01 A | 126.24 A | 126.24 A | |

It is clear from the previous results that some indicators of vegetative growth decrease with the increase in the level of salts in irrigation water, which may be due to the direct effects that increased salinity in the soil solution causes inhibiting the effectiveness of enzymes and the resulting imbalances in the food balance and the functions of cell membranes and plant metabolism in general (14, 18). The results of the previous tables show that all indicators of flowering growth decreased with increasing salt stress caused by increasing salinity of irrigation water. This decrease is due to an imbalance in the ion balance in plants resulting from increased absorption of sodium and chloride ions, offset by a decrease in the absorption of phosphorous, magnesium, calcium and potassium in addition to the effect of salts in the effectiveness of enzymes, especially enzymes related to bio-activities and plant metabolism, which is negatively reflected on the division and elongation of plant cells, thus leads to inhibiting growth indicators for plants (6, 26). It was observed from the previous results that spraying with salicylic acid significantly affected the traits of vegetative growth, such as plant height, percentage of dry weight as shown in Table (4). The reason for this is due to the role of salicylic in stimulating the production of Auxins and Cytokinins (22), where Auxins are considered one of the main factors in the activity of cambium within plants and working to increase the cellular division for the Meristematic cells largely and rapidly (10) that


ISSN 2072-3875

leads to an increase in plant height. The increase in plant length may also be attributed to the role of salicylic acid in inhibiting the production of ethylene (19) by stopping the activity of the oxidase ACC enzyme responsible for the accumulation of 1-acid carboxylic-aminocyclopropane-1 (ACC) and then the production of ethylene (13) and its role in stimulating the enzymes responsible for the carbon metabolization process as well as speeding up the formation of carbon metabolization pigments (chlorophyll) (15). We also note from the results that spraying with salicylic acid significantly affected the traits of flower growth represented by the number of inflorescences as shown in Table (6). This may be attributed to its role in increasing the products of carbonic metabolization, So, there is an excess of sugars that available to promote the growth of the flowering system (21), or its role in increasing Auxins (22), which leads to improving the flowering traits, where salicylic acid acts as an internal regulator for flowers leading to increase flower generation (9). This may be due to the role of salicylic acid in producing a strong total vegetative represented by the plant height and the increase in the number of leaves and their absorption of the largest amount of nutrients, in addition to its role in speeding up the carbon metabolization process (15). The results of the above tables show that spraying with vitamin E led to improving the indicators of vegetative growth under study, which could be due to its role in increasing cell division and the effectiveness of many enzymes such as the Phosphatase, β-amylase, Amylopactin, and Glucosidase enzyme or assisting in building other enzymes such as Lipase, α-amylase, and Protase (23). Perhaps as a result of increasing the absorption of macronutrients that increase their accumulation within the plant and thus lead to an increase in the division processes for plant cells and their differentiation and the preservation of chloroplast and its effect on the process of carbon metabolization and its products (11) which led to an increase in the plant height as shown in Table (1). The results of tables (5 and 6) also show that spraying with vitamin E led to an increase in flowering traits, which can be attributed to the entry of vitamins in all enzymatic activities and the increase in bio-activities and carbon building processes, which results in increased vegetative growth and production of amino and nuclear acids, which reflects positively on building Carbohydrates are transported from their places of manufacture to the rest of the plant, thus creating a balance between carbohydrate and protein substances, which is reflected in the differentiation of flower buds and an increase in the number of inflorescences as shown in Table (6). The reason for prolonging flowering period as shown in Table (5) may be due to the role of vitamins in reducing the effectiveness of the peroxidase enzyme and reducing the biological construction for ABA and stimulating the construction of cytokines, thus delaying flower senescence and increasing vase life in addition to the work of vitamins as antioxidants that protect cells and cell membranes and delaying senescence (7, 22). These results agree with (5) in the Rosa damascena plant and with (3) in the Dahlia variabilis L. plant and with (4) in the fenugreek plants. Vitamins reduce the loss of essential elements due to salinity and product when oxidative damage to plasma membranes (18). In addition to vitamins play an important role in increasing the transfer of electrons across cellular membranes through cytochrome by reducing the polarity of the plasma membrane and activating $H^+$-ATPase enzymes that result in increased absorption Ions, increase absorption processes, transfer ions and increase metabolic processes, which is reflected in the increase in carbon building processes, which results in increased plant growth, so plants treated with vitamins show high efficiency by inducing mechanisms to withstand salinity by Stimulating a wide system of enzymatic antioxidants as shown Table (11). There was an increase in the vegetative traits of Senna when spraying selenium as a result of the role of the element in increasing the total concentration of chlorophyll and removing the toxic effect of free radicals from the effective oxygen group


ISSN 2072-3875

(hydrogen peroxide root) through the glutathione peroxidase enzyme (20). As for the role of selenium in improving the flowering traits, it is due to an increase in vegetative growth when sprayed and increasing the concentration of chlorophyll as shown in Table (5 and 6), and increasing the accumulation of dry matter as shown in Table (4). The spraying with selenium led to an increase in the relative water content and reducing the deficiency of the saturated water, thus an increase in the Turgor pressure and the expansion and elongation of the cells and increasing their division and then increasing the flowering branches (12). The reason is also due to the role of the element in increasing the concentration of gibberellin, which has a role in encouraging Cellular flowering and elongation (21,24). The spraying with selenium also led to an increase in the traits of the table (7, 8 and 9). The reason for the increase is due to the role of the element in increasing the total concentration of chlorophyll, where it is believed that the trait of optical properties for selenium has a large role in the electron transport system, increasing the effectiveness of the enzyme Ribulose-1,5-bisphosphate carboxylase and inhibiting Photosynthesis leading to the production of free radicals and the accumulation of Glycolate due to the severity of stress and then the accumulation of dry matter as shown in Table (4). The role of the element in increasing the relative water content has led to an increase in the solubility of the dry matter and its flow of transmission to the growth areas of fruit and seed. It is also believed that the element has a role in preventing the oxidation of gibberellin by the GAoxidase enzyme and then increasing its concentration, which increases the division and growth of fruits and the production of seeds. Increasing the concentration of gibberellin also reduces the accumulation of Abscisic acid that leads to falling fruit (17). The role of selenium as an antioxidant by inhibiting it to produce free radicals and reducing the effectiveness of the analyzed enzymes and increasing the effectiveness of the antioxidant enzyme system (superoxide dysmutase, peroxidase, catalase, glutathione peroxidase) and its participation in most non-enzymatic antioxidants led to a decrease in the severity of stress and increasing fruit growth even when stress occurs, which improved the growth of fruits and seeds (8).

## REFERENCES

**1. Al-Sahuki, Medhat Majeed, Kareema and Waheeb. 1990.** Applications in designing and analyzing experiments. Dar Al-Hekma for Printing and Publishing. Mosul.

**2. Al-Amri, Maitham Mohsen, Sennarya Abbas and Liqa'a Jazie. 2009.** Morphological studies for Cassia Italica (Mill.) and the effect of alcoholic and hot water plant extract on different bacteria and yeast. Iraqi Journal of Market Research and Consumer Protection, 1 (1): 19-40.

**3. Al-Ali, Fakhria Abdullah Abd Al-Abbas. 2011.** Effect of punching and spraying with vitamins C and B3 and iron and zinc components on the growth and flowering of the Dahlia Variabilis L. plant, Ph.D. thesis, College of Agriculture, University of Basra.

**4. Jaber, Haider Sobeih Shanu. 2010.** Effect of plant number per hole and spraying with ascorbic acid on growth and seed yield of fenugreek (trigonella foenum-graecum l.) and some of its active components, Basra Research Journal, 97-88: (5) 36.

**5. Sadiq, Sadiq Mohammed. 2014.** Effect of spraying with ascorbic acid, alpha-tocopherol and some storing treatments on the growth and flowering of Rosa hybrid (Angelina cultivar). Master Thesis. Department of Horticulture and Landscape Gardening. College of Agriculture. Baghdad University.

**6. Abbas pour, H.; F. Fallahyan; H. Fahimi and H. Afshari .2006.** The response of *pistacia vera* L. in Salt tolerance to inoculation with arbuscular Mycorrhizal Fungi under Salt stress. Acta Hortic 726: 383 – 389.

**7. Barth, C.; M. De Tullio and P.L. Conklin.2006.** The role of ascorbic acid in the control of the flowering time and the onset of senescence. Journal of Experimental Botany. 57(8):1657-1665.

**8. Chai, Q.; Gan. Y. , Zhao, C., Xu, H., Waskom, R.M., Niu, Y. and Siddique, K.H.M. 2016.** Regulated deficit irrigation for crop production under drought stress. A review. Agron. Sustain. Dev., 36(3):1-21.

**9. Cleland. C.F. and A. Ajami 1974.** Identification of the flower- inducing factor isolated from aphid honeydew as being salicylic acid. Plant Physiol. 54: 904 _906.

**10. Coartney. J .S., D. J. More and J.L.Key .1967.** Inhibition of P RNA synthesis and auxin-induced cell wall extensibility and growth by actinomycin. Plant Physiol. 42: 434.

**11. Dowdle, J. ; T. Ishikawa; S. Gatzek; S.Rolinski and N. Smirnoff .2007.** Two genes in *Arabidopsis thaliana encoding* GDP–L–galactose phosphorylase are required for ascorbate biosynthesis and seedling viability. The Plant Journal, 52 (4): 673 – 689.

**12. El-Ramady, H.; Abdalla, N., Alshaal, T., El-Henawy, A., Faizy, S.D.E.A., Shams, M.S., Shalaby, T., Bayoumi, Y. , Elhawat, N., Shehata, S., Sztrik, A., Prokisch, J., Fári, M., Pilon-Smits, and Domokos-Szabolcsy, E. 2014.** Selenium and its Role in Higher Plants. Springer Inter., Pub. , Switzerland.

**13. Fan. X. , J. P. Matches and J.K. Fellowman 1996.** Inhibition of apple fruit l_aminocyclopropane_l_ carboxylic acid oxides activity and respiration by acetylsalicylic acid. J. Plant Physiol. 149: 469 _ 471.

**14. Hamdia, M.A and M.A.K. Shaddad .2010.** Salt tolerance of Crop plants. journal of stress physiology & biochemistry. 6.3: 64 – 90.

**15. Hayat, S. and Ahmed A., 2007.** Salicylic Acid: Biosynthesis, Metabolism and physiological Role in plants. Springer Netherland.

**16. Jabbarzadeh, Z.; M. Khui and H. Salehi. 2009**. The effect of foliar applied of salicylic acid on the flowering of African violet. *Australian Journal of Basic and Applied Sciences* 3(4): 4693– 4696.

**17. Jalal, A.G. and Jing-Quan, Y. 2016.** Plant Hormones under Challenging Environmental Factors. Springer.Netherland.

**18. Khan, T.A.; M. Mazid and F. Mohammad .2011.** A review of ascorbic acid potentialities against oxidative stress-induced in plants. J. Agrobiol. 28: 97 – 111.

**19. Lesilie, C. A. and R. J.Romani 1988**. Inhibition of ethylene biosynthesis by salicylic acid. Plant Physiol. 88: 833_837.

**20. Ponnu, J.; Wahl, V. and Schmid, M. 2011.** Trehalose-6-phosphate: connecting plant metabolism and development. Front. Plant Sci., 2(70): 1-6.

**21. Russell, C. R. and Morris D.A. 1983.** Patterns of assimilate dstribution and soyrce_sink relationships in young reproductive tomato Plant *(Lycopersicon escylentyn Mill* . ). Annals of Botany. 52: 357_ 363.

**22. Shakirova F.M.A.R. Sakhabytdinova, M.V.Bezrykova, R.A. Fatkhytdinova and D.R.Fatkhytdinova. 2003.** Changes in the hormonal status of wheat seedlings. induced by salicylic acid and salinity. Plant Science, 164(3): 317-322.

**23. Smirnoff N, and GL. Wheeler.2000**. Ascorbic acid in plants, biosynthesis and function. Biochemistry and molecular biology, 35(4):291-314.

**24. Ullah, H. 2012.** Fruit Yield and Quality of Anise(Pimpinella anisum L.) in Relation to Agronomic and Environmental Factors.

**25. Wang, M. Z.; Qingsong; S. Qirong and Shiwei G.2013.** The critical role of potassium in plant stress response. Int. J. Mol. Sci. 14(4) : 7370-7390.

**26. Younis M.E., M.N.A. Hasaneen; and A.M.S Kazamel .2010.** Exogenously applied ascorbic acid ameliorates the detrimental effects of NaCl and mannitol stress in *vicia faba* seedlings. Protoplasma.239(1). 39-48.

 ISSN 2072-3875