



Effect of Sulfur and Spraying with Calcium Nitrate and Selenium on Response of Date Palm (*Phoenix dactylifera* L.) under Saline Water

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Abstract: The study was conducted at Shatt al-Arab district, Al-Zurajji area, Basrah Governorate, to determine the effect of sulfur application and calcium nitrate and selenium spraying on some chemical and physiological traits of date palm (Halawi cultivar) under the saline conditions of Basrah Governorate. The results showed that the superiority of the sulfur addition at 500 g Palm⁻¹ and selenium spraying at a 0.01% on percentage of dry matter, dissolved solids, total sugars, and reducing sugars in fruits, chlorophyll, total carbohydrates, potassium concentration and K / Na ratio in leaves as compared to control. This treatment decreased significantly percentage of sucrose and water content in the fruits, and the concentration of proline and sodium element in the leaves as compared with the control. The addition of sulfur the concentration of 500 g Palm⁻¹ and spraying with calcium nitrate at concentration of 0.150% recorded significantly high percentage of membrane stability index and calcium concentration in leaves and decreased the percentage of potassium ions leakage.

Keywords: Sulfur, Calcium nitrate, Selenium, Date palm (*Phoenix dactylifera* L.), Halawi cultivar, Saline conditions

The date palm (*Phoenix dactylifera* L.) belongs to the Arecaceae and is a semi-tropical fruit tree. Halawi cultivar the famous varieties in the world, comes at the forefront of the early ripening and commercial exported by Iraq as the good-flavored dates. Iraq was the most important dates producing countries in the world, but the palm productivity is declining under the unfavorable environmental conditions, one of them is the salinity problem, which the most important factors affecting the success of palm cultivation and productive. Sulfur is the fourth important element in plant nutrition synthesis of some amino acids, such as cysteine and methionine, involved in building protein. The addition of sulfur to the soil increases the readiness of nutrients, especially the trace elements and absorption by plants. Calcium element from macronutrients has many physiological functions of plant growth and development, building the cell structure of plant and the main component of the cellular plate. The calcium peptides involved the phosphotidic acid formation, which contributes to cellular membrane synthesis (Hickman 2011). Several studies shown that this element is the secondary messenger in the plant's response to plant hormones, as well as environmental stress conditions. The calcium effective in plants ability increasing to salt stress tolerate, due to the integration maintenance of cellular membranes, the regulation of selective permeability in cellular membranes, particularly the plasma membrane. Selenium was classified as a non-enzymatic antioxidant and entered as an adjunct to the enzyme antioxidant system

(Abdel Nasser 2011), especially the glutathione peroxidase (Alazzawi and Faisal 2015). It has the opposite magnetic properties, causes the magnetic field creation, opposes another external magnetic field, free radicals possess a harmful and destructive magnetic moment for electronic equilibrium, leads to a reduction in the magnetic momentum of free radicals with supernatural forces, as selenium here dampens the free radical. Recent studies show that the selenium in stress tolerance, during several mechanisms, includes being anti-oxidative and anti-hydrogen peroxide, the effect of free radicals as the main part of the action of the glutathione peroxidase (GPX) enzyme, without this element toxic hydrogen peroxide molecule that accumulates as a result of stress into water and the cell remove of the toxic hydrogen peroxide effect, turns it into absolute water molecules. Gad El-Kareem et al. (2014) observed that spraying date palms by 0.1% of silicon element with selenium with a concentration of 0.02% significantly increase total chlorophyll and potassium element concentration in control. Tolima (2015) explained that the adding sulfur at a level of 400 g palm⁻¹ to the date palm resulted a significant increased dry matter, total sugars, the ratio of total dissolved solids and a decrease in acidity compared in fruit. The added selenium with irrigation water at a concentration of 15 mg. Kg⁻¹ to date palm led to a decrease in the toxicity of the element of cadmium by increasing chlorophyll, the stability index of chlorophyll, the membrane stability index, and reducing the accumulation of proline and hydrogen peroxide and the index

of lipid oxidation (Abbas 2018). Because of the lack of studies, about the use of sulfur, calcium and selenium combined, by added ground and spraying on date palm trees, under the environmental conditions of Basra Governorate, the present study was conducted to determine the effect of these elements on some chemical and physiological characteristics of date palm (*Phoenix dactylifera* L.) under the saline conditions of Basrah Governorate.

MATERIAL AND METHODS

The study was conducted at Shatt al-Arab district, Al-Zurajji area, Basrah Governorate to determine the effect of sulfur ground treatment, calcium nitrate and selenium spraying on some chemical and physiological traits of date palm (Halawi cultivar) under the saline conditions of Basrah Governorate. A total of 18 date palm (Halawi cultivar) were chosen as homogeneous as possible. The recommended agronomic practices were followed. The palms were pollinated on 25 March using the green Ganami vaccine and the flower inflorescences were reduced to 8 for each. The adding sulphur process to the soil was carried out by digging a trench around the stem of the palm with a depth of 30 cm and a width of 40 cm. Sulphur was scattered inside the trench at a rate of 500 g. Palm⁻¹ in two batches, the first in mid-November and the second in mid-February, after which the trench was covered with a layer of dirt. The calcium nitrate with a concentration of 0.0750 and 0.150%, the selenium element 0.005 and 0.01% concentration was sprayed in addition to control (without addition and spraying). The spraying process (the first spray) was started at the beginning of March, and the second spray took place four weeks after the pollination procedure (after the completion of the fruit contract). The spreading substance Tween 20 (0.01%) was added to the spray solutions and the spraying process in the early morning on the vegetative and fruity groups until complete wetness. The measurement of the traits of the leaves, took at the end of September by taking the foliage (pinnaes) from the leaf located in the third line. Before the study, an analysis of the orchard's soil was carried out (Table 1).

Chemical and Physiological Parameters in the Leaves

Total chlorophyll (mg. g⁻¹): was calculated according to the Holden method and according to the following formula: Total chlorophyll (mg L⁻¹) = 20.2 (O.D. 645) + 8.02 (O.D. 663). Total soluble carbohydrates (mg. g⁻¹) were estimated according to the method of Watanabe et al (2000) and proline (μ g⁻¹) was estimated according to Bates et al (1973). The estimation of potassium, sodium and calcium (mg g⁻¹) was done according to Page et al (1982) using the flame photometer. Potassium and sodium ratio was estimated by dividing the potassium

Table 1. Physical and chemical properties of orchard soil and irrigation water

Characteristics	Valuable
Electrical conductivity degree (E.C) d/m	14.8
Soil degree of interaction (PH)	7.96
Ready nitrogen (mg Kg ⁻¹)	193.88
Ready phosphorus (mg kg ⁻¹)	31.08
Ready potassium (mg kg ⁻¹)	98.36
Soil separations	%
Clay	50.09
Silt	37.62
Sand	12.29
Soil tissue	Alluvial clay
E.C irrigation water d/m	6.03

results by the sodium results. Ion leakage of potassium ions (%) was determined by the method described by Mangrich and Saltveit (2000). The Membrane Stability Index (MSI) (%) was based on method of Lutts et al (1996).

Chemical characteristics of the fruits:

$$\text{Water content (\%)} = \frac{\text{Soft sample weight} - \text{dry sample weight}}{\text{Soft sample weight}} \times 100$$

$$\text{Dry matter (\%)} = \frac{\text{Dry sample weight}}{\text{Soft sample weight}} \times 100$$

The total soluble solids content of the fruits was estimated using the Hand Refractometer and the reading was adjusted at a temperature of (20°C). Total and reducing sugars and sucrose in the pulp of fruits (%) in the stage of kalal was estimated by using the Lane and Eynone method.

The experiment included six treatments T₁- control (without addition and without spraying), T₂- add only sulfur at a rate of 500 g. Palm⁻¹, T₃- Sulfur 500 g + spray calcium nitrate at a concentration of 0.075 % , T₄- Sulfur 500 g + spray calcium nitrate at a concentration of 0.150 % , T₅- Sulfur 500 g + spray selenium at a concentration of 0.005 % and T₆-Sulfur 500 g + spray selenium at a concentration of 0.01 % .The experiment was carried out according to randomized complete block design, with six treatments and three replicates. The data were analyzed using the Genstat version 7.

RESULTS AND DISCUSSION

The treatment with chemicals substances had a significant effect on the fruit characteristics compared with control (Table 2). The sulfur addition at a concentration of 500 g. per palm was significantly superior than spraying with selenium at a concentration of 0.01%. The T₆ significantly records the highest content of dry matter in fruit, total soluble

solids, total sugars and reducing sugars, being 53.75, 43.11, 38.20 and 24.97% than in control being 42.02, 38.22, 32.44 and 17.63%. Sucrose and water content in T₆ decreased significantly, (13.23 and 46.25%) compared to the control (14.81 and 57.98%).

Improvement the fruit content of dry matter, total soluble solid and total sugars, and reducing sugars, when treated with sulfur, calcium nitrate and selenium, may be due to the role of sulfur in reducing the negative impact of soil salinity by reducing soil reaction (pH) and increasing the readiness of nutrients in the soil and facilitating their absorption by the plant at greater quantities, including nitrogen, phosphorus and potassium, which are important in building carbohydrates and amino and nuclear acids, and leads to an increase in the ratio of soluble solids and total sugars, and an increase in the proportion of dry matter, reflected positively on the quality of the fruits (Kassam 2012). This can also be due to the role of calcium in reducing salt stress, and regulating the selectivity of ions through the plasma membrane, especially sodium and potassium, which improves plant growth, reflected in the fruits quality (El-Khawaga 2013). Calcium was important in the growth and expansion of cells, because increases the elasticity of the cell wall, helps in the speed of carbohydrate transmission and

building proteins. The increase in chemical characteristics when treating selenium may be due to the element in the toxic removing, effect of free radicals formed from saline stress by the Gluxathion peroxidase (GPX) enzyme, as well as selenium increases absorption.

The treatment with sulfur and sprayed with calcium nitrate and selenium have a significant effect on physiological characteristics compared with control (Table 3). The addition of sulfur at a concentration of 500 g Palm⁻¹ and spraying with selenium at a concentration of 0.01%, recorder significantly higher total chlorophyll and carbohydrates in leaf 2.58 and 60.40 mg g⁻¹) compared to (1.26 and 46.46 mg g⁻¹). The same treatment (T₆) recorded significant decrease proline contents in leaves, the lowest (57.30 μ g⁻¹) compared to the control (84.59 μ g⁻¹). The treatment T₄ addition of sulfur at a concentration of 500 g. Palm⁻¹, spraying with calcium nitrate with 0.150% concentration, recorded the highest stability of membranes (75.09%) compared to the lowest stability of membranes in control (54.07%). The T₄ also recorded the lowest leakage of potassium ions K⁺ (5.30%) compared to the control with the highest potassium ion leakage of 10.41%.

The decreased salinity effect leads to a decrease in the concentration of proline in leaves, because the amino acid proline increases under the influence of salinity in response

Table 2. Effect of sulfur and sprinkling with calcium nitrate and selenium on some chemical characteristics of fruit of date palm in the kalal phase (%)

Treatments	Dry matter	T.S.S	Total sugars	Reducing Sugars	Sucrose	Water content
T ₁	42.02	38.22	32.44	17.63	14.81	57.98
T ₂	45.12	40.11	33.85	19.57	14.28	54.88
T ₃	47.13	41.18	35.67	21.78	13.89	52.87
T ₄	50.75	41.56	35.82	21.95	13.87	49.25
T ₅	51.37	42.03	36.09	22.40	13.69	48.63
T ₆	53.75	43.11	38.20	24.97	13.23	46.25
L.S.D (p=0.05)	1.17	1.12	1.34	1.02	0.37	1.17

Table 3. Effect of sulfur and sprinkling with calcium nitrate and selenium on some physiological characteristics in leaves the date palm

Treatment	Characteristics				
	Chlorophyll (mg g ⁻¹)	Carbohydrates (mg g ⁻¹)	Proline (μ g ⁻¹)	MSI (%)	Leakage K ⁺ (%)
T ₁	1.26	46.46	84.59	54.07	10.41
T ₂	1.59	51.40	79.37	63.86	7.67
T ₃	1.67	52.64	71.24	72.72	5.69
T ₄	1.88	54.24	65.58	75.09	5.30
T ₅	2.31	55.67	61.85	70.44	6.55
T ₆	2.58	60.40	57.30	71.00	6.16
L.S.D (p=0.05)	0.32	1.30	4.08	5.83	0.98

to plant resistance to salt stress due to the increasing decomposition of protein as a result of increasing the effectiveness of the enzyme protease under those circumstances. The increase in calcium treatment may be due to the role of positive calcium in the integration of cellular membranes, as well building the wall and membranes cells during a union with insoluble pectin, the formation of calcium peptides that increase the rigidity of cell walls, which helps to regulate the permeability of cellular membranes for water and nutrients, then improves plant growth. The increase when treated with selenium may be due to its combined role with enzymatic and non-enzymatic antioxidants, which enters in the synthesis of glutathione peroxidase, increases potency and works to sweep the toxic hydrogen peroxide the oxidizer of the plastid membranes and converting them into water molecules, reduce concentration and toxicity, or it may return to the role of selenium in its ability to increase the effectiveness of the antioxidant enzymatic system such as APX and SOD (Wu et al 2016). The increase in carbohydrates when treated with selenium may be due to increasing the concentration chlorophyll in the leaves, which leads to increased accumulation of additional carbohydrates.

The treatment with sulfur and sprayed with calcium nitrate and selenium had a significant effect on leaves concentration of mineral elements K, Na and Ca, and the ratio of K / Na compared to the control (Table 4) The addition of sulfur at a concentration of 500 g. Palm⁻¹ and spraying with selenium at a concentration of 0.01% recorded significantly highest potassium concentration and the ratio of K / Na in the leaves was 3.17 mg. g⁻¹ and 10.06 compared to the comparison treatment that recorded the lowest values of 1.52 mg. g⁻¹ and 2.08. The same treatment (T6) decreased significantly by recording the lowest values in the leaves content of the sodium element, amounting to 0.315 mg g⁻¹ compared to the control treatment(0.730 mg g⁻¹). There was a significant superiority of addition of sulfur at a concentration

of 500 g Palm⁻¹ and spraying with calcium nitrate at a concentration of 0.150% by recording the highest calcium in the leaves amounted to 3.74 mg g⁻¹ compared to the comparison treatment that recorded the lowest (1.58 mg g⁻¹).

K and Ca elements concentration were increasing in the leaves, reduced the concentration of Na when treating with sulfur, may be due to reducing the degree of soil interaction, and increasing the nutrients readiness in the soil, facilitating the absorption by the plant, includes potassium, a competition between potassium and sodium ion during potassium channels the selectivity in the plasma membrane in the root, which leads to a decrease in sodium ion absorption. The sulfur release of ready calcium in the soil, which increases the absorption, accumulation in the leaves through the effect of indirect sulfur through a reaction, with calcium carbonate in the soil, release ready calcium, which increases absorption and accumulation in the plant, the increase in the concentration of calcium in the leaves when sprayed with calcium nitrate, led to an increase in the content of the leaves from the element of calcium, by increasing the concentration used, which led to saturation of the leaves with this element, which causes to an increase in concentration in plant tissue, the effects were more pronounced on plant growth, while increase concentration K and Ca, and reducing the concentration of Na in the leaves when treated with selenium, may be due to as an anti-oxidant in external oxidative stress reduce, and improving ion balance in the leaves, this effect can also be due to improving the permeability of the membranes and increasing the accumulation of protein that protects the cellular membranes.

CONCLUSIONS

The treatment with sulfur and sprinkling with calcium nitrate and selenium has positive effects in the chemical and physiological parameters, which play a fundamental role in increasing the tolerance of date palm to inappropriate environmental stresses, which reflected positively on the characteristics of fruit growth.

REFERENCES

- Abbas KF 2018 The alleviation activity of selenium against cadmium phytotoxicity in date palm *Phoenix dactylifera* L. *Basrah Journal of Date Palm Research* **17**(1-2): 1-13.
- Abdel Nasser IM 2011. Selenium and its role in humans and animals. *Assiut Journal of Environmental Studies* **15**(1): 20-35.
- Alazzawi BH and Faisal NH 2015. Study of the biochemical association of Selenium with glutathione Peroxidase Enzyme as Antioxidants in Patients with Kidney Stone. *Journal of Basrah Research* **41**(2): 67-74.
- ALTemimi E 2021. Effect of spraying with Nano iron and zinc and their interactions on some physiological traits and yield for date palm fruits (*Phoenix Dactylifera*L) Al-BarhiCultivar. *Annals of*

Table 4. Effect of treatment with sulfur and sprinkling with calcium nitrate and selenium on the mineral elements in leaves of date palm

Treatment	Characteristics			
	K mg g ⁻¹	Na mg g ⁻¹	K/Na	Ca mg g ⁻¹
T1	1.52	0.730	2.08	1.58
T2	1.97	0.542	3.63	2.05
T3	2.28	0.438	5.24	3.41
T4	2.47	0.360	6.86	3.74
T5	2.88	0.339	8.49	2.95
T6	3.17	0.315	10.06	3.09
L.S.D (p=0.05)	0.36	0.121	0.69	0.35

- the Romanian Society for Cell Biology* **25**(6): 3742-3749.
- Bates LS, Waldren RP and Teare ID 1973. Rapid determination of free proline for water stress studies. *Journal of Plant and Soil* **39**(1): 205-207.
- El-Khawaga AS 2013. Effect of Anti-salinity agents on growth and fruiting of deferent date palm cultivars. *Asian Journal of Crop Science* **5**(1): 65-80.
- Gad El-Kareem MR, Abdel Aal MK and Mohamed AY 2014. The synergistic effects of using silicon and selenium on fruiting of Zaghoul Date Palm (*Phoenix dactylifera* L.). *International Journal of Agricultural and Biosystem Engineering* **8**(3): 259-262.
- Hickman AG 2011. Cooperative extension form advisor emeritus division of agriculture and natural sources University of California. *Asian Research Journal of Agriculture* **4**(2): 36-44.
- Mangrich ME and Saltveit ME 2000. Effect of chilling, heat shock, and vigor on the growth of cucumber (*Cucumis sativus*) radicles. *Physiologia Plantarum* **109**(2): 137-142.
- Kassem HA 2012. The response of date palm to calcareous soil fertilisation. *Journal of Soil Science and Plant Nutrition* **12**(1): 45-58.
- Lutts S, Kinet JM and Bouharmont J 1996. NaCl-induced senescence in leaves of rice *Oryza sativa* L. cultivars differing in salinity resistance. *Annals of botany* **78**(3): 389-398.
- Page AL, Miller RH and Keeney DR 1982. Methods of soil analysis, part 2. *Chemical and Microbiological Properties* **2**(1): 643-698.
- Ponnu J, Wahl V and Schmid M 2011. Trehalose-6-phosphate: connecting plant metabolism and development. *Front. Plant Science* **70**(2): 1-6.
- Watanabe S, Kojima K, Ide Y and Sasaki S 2000. Effect of saline and osmotic stress on proline and sugar accumulation in *Populus euphratica* in vitro. *Plant Cell Tissue Organ Culture* **63**(3): 199-206.
- Wright GG, Patten KD and Drew MC 1994. Mineral composition of young rabbiteye and southern high bush blue berry exposed to salinity and supplement calcium. *Journal of the American Society for Horticultural Science* **199**(2): 229-236.
- Wu Z, Yin X, Banuelos GS, Lin ZQ, Liu Y, Li M and Yuan L 2016. Indications of selenium protection against cadmium and lead toxicity in oilseed rape (*Brassica napus* L.). *Front. Plant Science* **7**(1): 1875-1882.

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