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# EFFECT OF SOME MECHANISMS IN TREATING SALT STRESS IN THE PRODUCTION OF DATE PALM (*PHOENIX DACTYLIFERA* L.)

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## Abstract

The experiment conducted during the 2017 growing season in one of the national orchards in Abu al-Khaseeb district. It was to study the effect of nutrients and the methods of adding them in the treatment of salt stress and improving the qualitative and productive characteristics of a type of date palm called Hilawi. The experiment included eight treatments, which are interactions between two methods of addition (spraying and ground addition) and three salt treatments in addition to the comparison treatment. The results can be summarized as follows: The superiority of the treatment (2 ml / liter fertilized nanotic), significantly compared to the two treatments 2 ml / liter seamino and 2 ml / liter of a Delzi growth stimulator giving the highest increase in the qualitative characteristics of the fruits (weight and size of the fruit, reducing sugars, total sugars, low sucrose and the effectiveness of the Invertase enzyme activity). Also, there was an increase in the productive characteristics maturity percentage and total productivity. The results also showed that the ground addition method for salt stress treatments is significantly outweighed the highest increase in the qualitative characteristics of fruits (fruit weight, reducing sugars and low Invertase enzyme activity), as well as the increase in productive characteristics (total yield and low rate of fruit loss). While superiority did not show significant differences between the two methods of addition (spraying and ground addition) in the average size of the fruit, glucose and total sugars and the fruit maturity percentage. Besides, there was an increase in the productive characteristics (maturity percentage and total yield) and there was a decrease in the percentage of fruit drop compared to the two comparative treatments (distilled water, added though spraying and distilled water and a ground addition), at which the lowest significant decrease in the weight and size of the fruit, reducing sugars, total sugars, maturity percentage, total yield and highest significant increase in the rate of sucrose and the activity of the enzyme Invertase percentage of fruit loss was achieved.

***Key words:*** date palm, salinity, salt treatments, addition methods.

## Introduction

The date palm tree belongs to *Phoenix dactylifera* L., Order: Palma and the Family: Arecaseae, which contains about 220 genera and 2,600 species and is considered one of the most important plant families known to man. Palm cultivation is a cornerstone of the agricultural environment of Iraq. Also, palm tree orchards are used to grow various different types of fruit and vegetable trees (Al-Douri and Al-Rawi, 2000). Iraq is deemed one of the oldest palm cultivation habitats in the world, with an area of 76400 hectares *and* the number of palm trees in it is about (16492121) palm trees and fruit trees reach about 10218000 palm trees. There is a kind of palm tree called "Hilawi" is considered one of the commercial products that Iraq exports to many countries of the world. The number of palm trees of this type "hilawi" s about 517,026 palm trees and the number of fruit trees from it is 359,585 palm trees (Central Statistics Authority, 2015). At the current time, the problem of salinity is one of the most significant problems facing the countries of the world. The areas affected by salinity in the world constitute between 20 to 50% of the lands cultivated, whether they are irrigated or rainfed (Lauchli and Luttge, 2004).

There are two main effects of salt stress in plants like the change of osmotic potential and the occurrence of ionic poisoning in addition to the secondary damages that affect all vital processes in plants (Yadav *et. al.*, 2011). Date palm trees are among the plants tolerant of salinity and the extent of the date palm trees tolerance to salinity greatly exceeds the tolerance of many other fruit

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trees. However, their productivity decreases with increasing salinity in the area of root spread. It is not recommended to farm date palms in lands whose salinity exceeds (7000) *ppm* in root zone spreading area (United Nations Development Program, 2006).

The use of salt stress treatments, especially nutrients, in the field of agriculture at the present time has become "a must" to overcome the soil problems, especially the problem of salinity, which is described as one of the most realistic problems in Iraq and reducing salt stress on plants by providing mineral elements standby for absorption by the plant and preserving them from washing and fixing Improving the ion balance within the soil solution and the osmotic pressure inside the plant. Due to the lack of ready-made nutrients for the plant, there is a cause to a decrease in the activity of the antioxidant enzymes and thus the plant's sensitivity increases to different environmental stresses (Kaviani and Ghaziani, 2014). As there is a notable shortage of studies related to the effect of nutrients and organic nanoparticles on date palm trees under local stress conditions and testing the date palm trees "hilawi" in response to added treatments and methods of its addition, so this study was conducted in order to:

1. Determine the type of nutrient in giving the best significant results in treating salt stress and improving the qualitative and productive characteristics of date palm.

2. Determine the optimal addition method for salt stress treatments in giving the best significant results in the qualitative and productive characteristics of date palm.

3. Determine the cross-impact between types of treatments for salt stress and addition methods to the specific and productive characteristics of date palm.

## Materials and Methods

### Location of the Study

This study was conducted during the growing season of the year 2017 in one of the orchards of Abu Al-Khaseeb district in Basra city. About 27 "hilawi" palm trees were elected on the basis of symmetry in the strength of vegetative growth and being of zero diseases. A palm - tree orchard of 13 years old cultivated in mixed mud soil of (5×5 M) cultivation dimensions was selected. Palm trees were identified in the experiment by placing numerical signs on them according to the treatment and the duplicate.

All usual agricultural service operations were carried out for weeding, control and fertilization. The trees were fertilized with organic fertilizer (degraded beef fertilizer) by 5 (kg / per a palm tree) in January. Palm trees were pollinated with the green Ghannami vaccine on 21 March. The number of fruit clusters for each palm tree was (6) clusters. Soil and water samples were analyzed in the laboratories of the Faculty of Agriculture - University of Basra, where a soil sub-sample (randomly distributed at a depth of 0-30) cm. The sample was dried aerially and gravel and impurities were removed, then it was crushed and sieved with a sieve of (2 mm) capacity and preserved in a plastic container for laboratory analysis purposes. Analysis of the soil sample was carried out in the laboratories of the Faculty of Agriculture - Basra University *and* some chemical and physical properties of the sample were estimated (soil and irrigation water) as shown in table 1.

### Study Treatments

The study has included a factorial experiment with two treatments:

1. Treatments for salt stress (delzi growth stimulant, Seamino organic fertilizer and Nano-fertilized agricultural fertilizer- Cal-Pure Plus) are added at a concentration of 2 ml / liter for each of them in two sessions. The first session is added after two weeks of vaccination and the second after four weeks of pollination.

2. The addition method: adding salt stress treatments in two ways, first spraying to the vegetative and fruit groups and the second method is a ground addition (watering) by 15 liters / per a palm tree.

3. Correlation between the two treatments of the study (treatments for salt stress and methods of addition).

### Preparation of Fertilizer Solutions

The solutions used in the study were prepared *(bio growth promotor*, Seamino organic fertilizer and agricultural fertilizer nanoparticle Protec-Cal-Pure Plus) shown in table (2, 3, 4) by taking 2 ml of it and diluting it with distilled water to one liter, while using distilled water a for comparison treatment.

**Table 1:** Table of soil and irrigation water analysis for palm trees orchard.

| The value | Unit | Property |
|---|---|---|
| 8.74 | 1:1 | Soil reaction (pH) |
| 18.88 | Ds/m | Electrical conductivity (EC) |
| 26.90 | g/kg | Calcium carbonate (CaCo3) |
| 189 | g/kg | Organic material (O M) |
| 201.159 | g/kg | (sand) |
| 480.340 | g/kg | (clay) |
| 318.501 | g/kg | (silt) |
| Clay mixture | | Soil tissue |
| 150 | cm | Water depth Abrda |
| 6.63 | Ds/ m | E.C. of irrigation water |
| 3.53 | mM/ L | SAR |

**Table 2:** Contents of the *bio growth promotor (Dilzy).*

| Calcium | Magnesium | Boron | Molybdenum | Zinc | Cobalt | Di, Tri And poly saccharides | Uranicacid | Materials |
|---|---|---|---|---|---|---|---|---|
| 12 | 2 | 0.14 | 0.023 | 0.05 | 0.12 | 25 | 0.2 | concentration % |

**Table 3:** Contents of Seamino Organic Fertilizer.

| Materials | N | P2O5 | K2O | Amino acids | Seaweed extract |
|---|---|---|---|---|---|
| concentration % | 3 | 4 | 8 | 10 | 15 |

**Table 4:** Contents of Nano-Fertilizer Protect-Cal-Port Plus.

| Materials | K2O | B |
|---|---|---|
| concentration % | 15 | 0.5 |

## Preparation of Vegetable Samples

Fruit samples were collected by taking 25 fruits randomly from each date palm during the two phases of *khulal* (early stage of date palm fruit) growth (16 weeks after pollination) to measure the physical properties and in the phase of being a mature fruit (*rutab*) after (22 weeks following pollination) based on Owda *et al*., (2019) to measure the chemical properties of the fruits. The yield of each date palm after 26 weeks of pollination during the date palm yield phase was collected.

## Qualitative Characteristics of Date Palm Fruits

Fresh Weight of the Fruit: The weight of the fresh fruit was calculated by taking 25 fruits randomly from each refined using a Sartorius sensor scale, then the average weight of the fruit per unit was calculated in grams per unit by dividing the total weight of the fruits by the total number of fruits as shown in the following formula:

$$\text{Average Weight of the Fruit (gram)} = \frac{\text{Fruit Weight (g)}}{\text{Total Number of Fruits}}$$

Fruit Size: The size of the fruit was measured according to the method of the inserted cylinder and the distilled water displaced resulting from placing 25 fruits inside the inserted cylinder where a known volume of distilled water was placed in the inserted cylinder and the fruits that were weighed were submerged inside the inserted cylinder and the volume was measured by finding the difference between the water level in both cases. Then, the average volume of one fruit is calculated by dividing the volume of the displaced water by the number of fruits, according to the size in unit ($cm^3$).

## Reduced Sugars, Sucrose and Total Sugars (%)

Reduced sugars, sucrose and total sugars in fruit during the "*rutab*" phase were estimated at the laboratories of the Department of Horticulture and Gardening Engineering at the Faculty of Agriculture - University of Basra using the Lane and Eynon method which depends on the reduction of blue copper ions to red-copper-ions mentioned in Howrtiz, (1975) pursuant to percentage of Reduced Sugars, Sucrose and total sugars in line with what Howrtiz mentioned in a study in 1975 in line with the following formula:

$$\text{Reduced sugars (\%)} = \frac{\text{mg of sugar (from the table is equivalent to reading an area)} \times \text{Dilutions} \times 100}{\text{Sample weight} \times 1000}$$

Sucrose (%) = Total Converted Sugars% - Reduced Sugars% × 0.95

Total sugars(%)= reduced sugars(%) + sucrose(%)

## Activity of Enzyme Invertase

The enzymatic activity of the date palm fruit was estimated by the date palm named "*hilawi*" in the *khalal (early stage of palm date fruit)* and fresh growth phases per week, once a week, starting from the week $16^{th}$ until the $22^{nd}$ week after pollination. The enzymatic activity has been estimated in the laboratories of the Department of Horticulture and Gardening Engineering - College of Agriculture - University of Basra and according to the steps stated below:

1. Preparation of Extraction Solutions: Extraction solution No. (1) 0.06 molar of ascorbic acid (pH = 7.5) prepared by dissolving 10.5678 grams of ascorbic acid in a given volume of distilled water and the volume was completed to a liter after adjusting the pH value to 7.5.

Extraction solution No. (2) phosphate regulator: 0.25 molar potassium phosphate + 0.06 molar ascorbic acid (pH = 7.5). The solution was prepared by dissolving 34.0225 grams of potassium dihydrogen phosphate ($KH_2PO_4$) with 10.5678 grams of ascorbic acid in a given volume of distilled water and volume was completed to a liter after adjusting the pH value to 7.5.

2. Preparation of Enzymatic Activity Solutions: Test solution No. (1) Solution 2 molar phosphate regulator (pH = 4.7)

The solution was prepared according to the method described by Christian (1980).

Test solution (2) Sucrose solution (0.1 M Sucrose): The solution was prepared by dissolving 34.2 grams of Sucrose in a liter of phosphate regulator solution, test solution No. (1) and this solution was used to measure the effectiveness of the Invertase enzyme after adjusting the pH value to 4.0.

Test solution No. (3) (DNSA) solution Dinitro

Silicylicacid 3.5: The solution was prepared according to the method described by Taya *et al*., (1985).

3. Extraction Method: The extraction process was conducted according to the method mentioned in a study carried out by Al-Bakir and Whitaker in 1978.

4. Estimating Activity of the Invertase Enzyme: The activity of Invertase enzyme was chosen by taking 5 ml of test solution No. (2) (Sucrose) which was subject to the enzyme in the test tube *and* incubating for 5 minutes at a temperature of 35°C. After that 0.5 ml of the enzymatic solution was added to each tube (this is the beginning of the reaction). Tubes were shaken well and placed in a water bath at a temperature of 35°C for a period of 20 minutes.

Following that, 0.5 ml of test solution No. (3) was added to each tube, then tubes were cooled using cold water.

Thereafter, spectrum absorption of each sample was calculated in the Spectrophotometer UV device with a wavelength of 540 nm. In the same way, a blank solution or zero solution was prepared, as 0.5 ml of test solution No. (1) (phosphate regulator solution) was added instead of the enzymatic solution.

**Productive Qualities**

Maturity Percentage: It was calculated on the basis of the number of fruits when they entered the softness of dates phase, which represents the beginning of date softness, by taking ten pieces of a cluster for each refined. The number of ripened fruits (soft dates) and the number of immature fruits (*khalal*) were calculated. Then the total ripening rate was extracted by adding the percentage of ripening and dividing it by the number of weeks. The percentage of ripening was calculated from the following formula:

$$\text{Ripening percentage} = \frac{\text{Number of ripening fruits (soft dates)}}{\text{The total number of fruits}} \times 100$$

Drop Percentage (%): The drop percentage was calculated from the following equation:

$$\text{The percentage of drop} = \frac{\text{The number of fruits after setting - the number of remaining fruits at collection}}{\text{The number of fruits after setting}} \times 100$$

Total Aggregate Quantity (kg): The resulting quantity was measured in the *tamur* phase, after collecting the fruits for each palm tree separately, then weighed by a field balance and then the total collected fruits was extracted for each treatment.

**Statistical Design and Parameters Used**

The experiment was carried out using the Factorial Experiment in Randomized complete Block Design by three sectors. Each palm tree represented one experimental unit and the results were analyzed using the analysis of variance adopted in the study of the physical and productive characteristics of the *hilawi* date palm trees. Averages were tested using the Revised Least Significant Differences Test (RLSD) method following a study conducted by al-Rawi and Khallafallah in 2000.

## Results and Discussion

1. Weight of the Fruit: The results shown in table 5, illustrate the significant effect of treatments for salt stress and methods of addition and their interference in the fruit weight percentage. The fruit weight property was affected significantly when treating palm trees with different types of nutrients as treatments for salt stress. The palm trees varied in their response, as the concentration gave 2 ml / liter of the fertilized agricultural nanoparticles (Protecal Pore Plus) the highest average fruit weight 9.515 grams, which did not differ significantly from the treatment 2 ml / liter organic fertilizer (seamino) in the effect with an average fruit weight of 9.340 grams compared to other treatments under study. The reason for this issue may be due to the fact that treating *hilawi* palm trees solution with the agricultural nanofeed and organic fertilizer created a good nutritional condition for the trees treated with them. This led to a state of balance between the mineral elements, which helped in the activation of photosynthesis processes, carbohydrate formation, building nucleic acids and the accumulation of proteins that are an influencing factor in the growth and development of fruits. Because addition of nutrients to plants is an effective way to reduce the negative effects of salt stress (Hamayun *et al*., 2011, Mengel and Kirkby, 1982).

As results shown in table 5, the addition method had a significant effect at (significance level 0.05) on the average fruit weight, as the ground addition was superior by giving the highest average fruit weight 9.005 grams and significant differences compared to the spray method, at which the fruit weight rate reached 8.398 grams. The reason for this is that the addition of treatments to date palm trees added ground (watering) led to address the shortfall in the concentration of nutrients ready for the plant due to salt stress. Abbas, (2013) stated that the soil fertilization programs enable the plant to tolerate salt stress through the use of the concept of alleviation means mitigation of the harmful effect for saline stress, as well as the use of the concept of amendment or amelioration which refers to improving the state of salt stress by applying ground fertilization programs that increase the readiness of the nutrients of the plant and thus enable the plant to withstand the conditions of salt stress.

**Table 5:** Effect of salt stress treatments, addition methods and their interactions on the average fruit weight (gram).

| Khallaal stage | | | |
|---|---|---|---|
| **Average effect of salt stress treatments** | **Addition methods** | | **Treatments for saline stress** |
| | **Ground addition** | **Add spray** | |
| 7.095 | 7.10 | 7.09 | 0 |
| 8.855 | 9.26 | 7.09 | Dilzy (2ml / L) |
| 9.34 | 9.73 | 8.95 | Seamino (2ml / L) |
| 9.515 | 9.93 | 9.10 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =0.1182 | 9.005 | 8.398 | Average effect of addition methods |
| | RLSD to the effect of interference =0.2360 | | RLSD for the effect of adding methods =0.1927 |

As shown in table 5, there was a significant effect of interference between concentrations of salt stress treatments and methods of additions to the average fruit weight, as the treatment (2 ml / liter nanoparticle fertilizer + ground addition) excelled in giving the highest fruit weight at a rate of (9.93) grams compared to the two treatments of comparison (distilled water + spray and distilled water + ground addition). The lowest rate of fruit weight (7.09 and 7.10) was achieved on the sequence as all other interference factors achieved significant superiority over the comparison treatment, which indicates that there is an interaction between the two treatments of study (salt stress treatments and its methods of addition). Hence it is quite necessary both treatments with palm trees (*hilawi tamur*) to get the best rate for the weight of the fruit.

## Fruit Size

The results of the statistical analysis, table 6, showed that the treatment of date palm trees with nanofed (Protic Cal Port Plus) had a significant effect on increasing the size of the fruit and the concentration (2 ml / liter) caused the highest average size of the fruit (8.63 $cm^3$). The size of the fruit was consistent with the increase in the weight of the fruit (Table 5). The reason for this may be attributable to the fact that the nanomaterials show different properties compared to when they are in their traditional dimensions (Naderi, 2012).

When treating *hilawi* palm trees with nanomaterials, where it fed palm trees with two Calcium and Boron elements.

Both elements had a cause to increase cells division and generation, which led to an increase in the size of the fruits in particular, Boron, which is important in stimulating enzymatic reactions, maintaining water balance and regulating osmotic effort in the plant (Owda *et al.*, 2019). Also, Calcium is an activator for cell metabolism enzymes such as cyclic neucleotide, phosphates, Adenine cyclase, in addition to its important role in increasing the plant's tolerance to salinity as it contributes to regulating the integration of selectivity of ions across the plasma membrane, particularly sodium and potassium ions (El Sharkawy *et al.*, 2017). The results of the statistical analysis in table 6, showed that there were no significant differences between the two methods of addition on the average fruit size.

The nature of the interference between treatments for salt stress and its addition methods to *hilawi* palm trees had a significant effect on the average fruit size as mentioned in table 6. The treatment (2 ml / liter fertilized nanoparticle + ground addition) excelled in giving the highest size of the fruit at a rate of (8.72) $cm^3$ which did not differ significantly from treatment (2 ml / liter of nanofed fertilized + spray) at a rate of the size of the fruit (8.54 $cm^3$). All other interference treatments achieved a significant superiority over the comparison treatment and the reason for this may be due to the compatibility of the concentrations of the added nutrients with the methods of adding them, which led to an increase in vital processes in plants, such as photosynthesis and respiration, which are linked to an increased rate of growth of the fruit which was reflected positively on the increase size of the fruit. Sadly, palm tree orchards suffer from the neglect of the farmers. Such neglection and the lack of agricultural service operations aimed to palm trees led to a decrease

**Table 6:** Effect of salt stress treatments, its addition methods and their interferences on average fruit size ($cm^3$).

| Khallaal stage | | | |
|---|---|---|---|
| **Average effect of salt stress treatments** | **Addition methods** | | **Treatments for saline stress** |
| | **Ground addition** | **Add spray** | |
| 7.175 | 7.20 | 7.15 | 0 |
| 7.84 | 7.93 | 7.75 | Dilzy (2ml / L) |
| 8.205 | 8.32 | 8.09 | Seamino (2ml / L) |
| 8.63 | 8.72 | 8.54 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =0.2452 | 8.043 | 7.883 | Average effect of addition methods |
| | RLSD to the effect of interference =0.3892 | | RLSD for the effect of adding methods =0.2183 |

**Table 7:** Effect of saline stress treatments, addition methods and their interactions on reducing sugars%.

| Rutab stage | | | |
|---|---|---|---|
| **Average effect of salt stress treatments** | **Addition methods** | | **Treatments for saline stress** |
| | **Ground addition** | **Add spray** | |
| 52.59 | 52.45 | 52.73 | 0 |
| 55.66 | 56.45 | 54.87 | Dilzy (2ml / L) |
| 56.93 | 57.60 | 56.26 | Seamino (2ml / L) |
| 59.305 | 60.15 | 58.46 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =0.7680 | 56.663 | 55.58 | Average effect of addition methods |
| | RLSD to the effect of interference =1.1072 | | RLSD for the effect of adding methods =0.5326 |

in the average size of the fruit over the years because such neglect and lack led to a high rate of soil salinization and depletion of mineral materials to the extent to which trees were unable to produce effectively (Kah *et al*., 2018).

**Reducing Sugars, Sucrose and Total Sugars (%)**

The results in table 7, illustrate the presence of significant differences in the rate of reducing sugars in the fruits of *hilawi* palm trees as a result of being treated with some treatments of salt stress. The treatment (2 ml / liter enriched nanoparticles) was superior and gave the highest rate of reducing sugars (59.305%), while the comparison treatment caused the lowest rate of reducing sugars by (52.59%) along with significant differences compared to other treatments under study. As for the effect of salt stress treatments on the percentage of Sucrose, the results showed in table 8, the comparison treatment significantly increased in the percentage of Sucrose for date palm fruits (9.85%) compared to the treatments used to reduce salt stress, at which there was a decrease in fruits of Sucrose and the lowest rate of Sucrose occurred at treatment 2 ml / liter organic fertilizer which was not significantly different from treatment 2 ml / liter enriched agricultural nanofed where they had a rate of Sucrose (8.55 8.285)%, respectively.

With regard to the effect of salt stress treatments on the percentage of total sugars of fruits, results showed in table 9, the superiority of the treatment (2 ml / liter of agricultural nanotic fertilized) significantly in giving the highest rate of total sugars by (67.59%) compared to the rate of total sugars achieved with other treatments which, in turn, significantly outperformed the comparison treatment, which achieved the lowest total sugars (62.44%) in the fruit of the *hilawi* palm trees.

This may be due to the fact that the fertilizers prepared with nanotechnology release elements on demand and thus prevent transformation of these elements into chemical and gaseous forms that cannot be absorbed by plants. And this can be achieved by preventing the nutrients from directly interacting with the soil, water.

Microorganisms and releasing the nutrients slowly and steadily depending on the actual plant need and absorbance by the roots (Tanou *et al*., 2017). As for the effect of the addition method on the fruit content of reducing sugars, the results in table 7, showed the significant superiority of the treatment (ground addition) in giving the highest rate of reducing sugars (56.663%), while the lowest rate of reducing sugars was achieved with the method of adding salt stress spray treatments (55.58%). With regard to Sucrose, it was noted from the results of the statistical analysis, table 8, that there were no significant differences between the two methods of addition on the percentage of Sucrose. The total sugars took a similar behavior to the Sucrose in response to the addition method. It was noted that the highest percentage of total sugars achieved with the treatment (ground addition) as it reached at (65.455%). This percentage did not differ significantly from the lowest total sugars rate (64.750%) achieved with the addition treatment of spray to the plant, table 9.

With regard to the effect of the interference between treatments of saline stress and the methods of addition, the results of the statistical analysis referred to in table 7, showed the superiority of the treatment (2 ml / liter fertilized nanoparticle + ground addition) significantly in giving the

**Table 8:** The effect of saline stress treatments, their addition methods and their interactions on Sucrose levels%.

| Rutab stage | | | |
|---|---|---|---|
| **Average effect of salt stress treatments** | **Addition methods** | | **Treatments for saline stress** |
| | **Ground addition** | **Add spray** | |
| 9.85 | 9.72 | 9.98 | 0 |
| 9.24 | 9.10 | 9.38 | Dilzy (2ml / L) |
| 8.55 | 8.23 | 8.87 | Seamino (2ml / L) |
| 8.285 | 8.12 | 8.45 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =0.4360 | 8.793 | 9.17 | Average effect of addition methods |
| | RLSD to the effect of interference =0.8905 | | RLSD for the effect of adding methods =0.2673 |

**Table 9:** The effect of salt stress treatments, their addition methods and their interactions on total sugars%.

| Rutab stage | | | |
|---|---|---|---|
| **Average effect of salt stress treatments** | **Addition methods** | | **Treatments for saline stress** |
| | **Ground addition** | **Add spray** | |
| 62.44 | 62.17 | 62.71 | 0 |
| 64.90 | 65.55 | 64.25 | Dilzy (2ml / L) |
| 65.48 | 65.83 | 65.13 | Seamino (2ml / L) |
| 67.59 | 68.27 | 66.91 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =0.9862 | 65.455 | 64.75 | Average effect of addition methods |
| | RLSD to the effect of interference =1.1530 | | RLSD for the effect of adding methods =0.8237 |

highest percentage of reducing sugars (60.15%) compared to the lowest percentage of reduced sugars achieved with the ground addition + distilled water (comparison treatment). The average percentage of sugars reduced thereto was (52.45%), while the rate of Sucrose took a different behavior, as it was evident from table 8. The highest significant superiority of Sucrose was achieved with two comparative treatments that did not significantly differ. On the other hand, they were significantly (9.98% and 9.72%), whilst the lowest percentage of Sucrose was achieved with treatment (2 ml / liter enriched agricultural nanofed + ground addition) by (8.12%). As for total sugars, the results of the study showed in table 9, disclosing that the interference factors between salt stress treatments and the methods of addition brought a significant superiority in the fruit content of the total sugars, as they exceeded significantly in the content of the date palm fruits in giving the highest rate of total sugars (68.27%) compared to the addition treatment (spray or ground) at the comparison treatment (distilled water), which gave the lowest total sugars rate (62.71% and 62.17%) in respectively. The above results can be explained on the fact that the effect of factors which are singular make the property under the influence of one stimulus by virtue of its averages in the event that the stimulus is a productive factor (salt stress treatments) or an auxiliary factor (addition method) which controls the ability of the plant to show its response or not. However, this equation differs a lot, if not radically, in the case of the interference of the two factors together, where the control in determining a property has two directions of effects (Ressan and Al-Temimi, 2019). Or this could be attributed to the efficiency of the added salt stress treatments, which achieved a balanced osmotic pressure inside and outside fruits, thus reducing the effect of salt stress, which led to an increased response of the palm trees under study. Then, this leads to improving the quality of the fruits (Kaviani and Ghaziani, 2014).

### Effectiveness of the Enzyme Invertase

Table 10, shows the effect of factor of palm trees with some salt stress treatments. The effectiveness of the Invertase enzyme had decreased significantly. The treatment gave 2 ml / liter agricultural Nano-fertilized the highest decrease in the activity of the enzyme (1534.720 units / kg) fresh weight of fruits compared to the comparison treatment (1697.155 units / kg) fresh weight of fruits. It should be noted that the two treatments, 2 ml / liter organic fertilizer and 2 ml / liter growth stimulus, had a significant effect in reducing the effectiveness of the enzyme Invertase compared to the comparison treatment. From these results, it is clear that the quantitative effectiveness of the enzyme Invertase follows the rate of accumulation of sucrose. This was demonstrated by Ati *et al.*, (2019) in their studies on the two types of date palm trees: *Hilawi and Birhi*, respectively. The reason may also be due to an increase in the fruit ripening percentage when treated with different types of salt stress treatments, because it contains a group of elements necessary to stimulate growth and push the fruits towards ripening. This made the fruits ripen faster than untreated fruits (Ressan and Al-Temimi, 2019), which was reflected on the activity of the enzyme Invertase. The method of adding salt stress treatments to the palm trees has had a significant effect on the activity of the enzyme Invertase as

**Table 10:** Effect of salt stress treatments, addition methods and their interferences on enzyme Invertase rate.

| Rutab stage | | | |
|---|---|---|---|
| **Average effect of salt stress treatments** | **Addition methods** | | **Treatments for saline stress** |
| | **Ground addition** | **Add spray** | |
| 1697.155 | 1683.20 | 1711.11 | 0 |
| 1650.920 | 1623.26 | 1678.58 | Dilzy (2ml / L) |
| 1608.070 | 1582.24 | 1633.90 | Seamino (2ml / L) |
| 1534.720 | 1527.83 | 1541.61 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =33.1200 | 1604.133 | 1641.300 | Average effect of addition methods |
| | RLSD to the effect of interference =48.8200 | | RLSD for the effect of adding methods =26.3400 |

**Table 11:** Effect of salt stress treatments, addition methods and their interferences on fruit ripening percentage %.

| Rutab stage | | | |
|---|---|---|---|
| **Average effect of salt stress treatments** | **Addition methods** | | **Treatments for saline stress** |
| | **Add spray** | **Add spray** | |
| 60.685 | 60.72 | 60.65 | 0 |
| 74.260 | 74.41 | 74.11 | Dilzy (2ml / L) |
| 84.185 | 84.48 | 83.89 | Seamino (2ml / L) |
| 85.030 | 85.38 | 84.68 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments = 1.2980 | 76.248 | 75.833 | Average effect of addition methods |
| | RLSD to the effect of interference = 1.5418 | | RLSD for the effect of adding methods = 1.1170 |

pinpointed in table 10. The rate of enzyme activity reached at (1641.300) units / kg fresh weight of fruits with the method of addition through spray. As to the ground addition method, the rate of enzyme effectiveness was (1604.133) unit / kg fresh weight of fruits. The reason for this may be due to the treatment of *hilawi* date palm trees with salt stress treatments that led to fasten fruit ripening as we will notice later by increasing the ripening ratio of the fruits with the ground addition of salt stress treatments, which led to a decrease in the activity of enzyme Invertase.

The results of the study showed that the nature of the interference between treatments of salt stress and its methods of addition to the *hilawi* palm trees had a significant effect on the effectiveness of the enzyme Invertase, as figured out in table 10. The treatment (2 ml / liter of nanoparticle fertilizer + ground addition) gave the highest significant decrease in the activity of the enzyme (1527.83) units/fresh weight kg of fruits, which did not differ significantly from the treatment of interference (2 ml / liter nanofed fertilizer + spray). Therefore, the rate of enzyme activity with it reached at (1541.61) units / kg fresh weight of fruits compared to the comparison treatments of the two methods of addition by spray and ground addition (1711.11 and 1683.20) unit / kg fresh weight of fruits sequentially.

Yamaki, (1995) pointed out that the activity of the enzyme Invertase during the stages of growth and ripening following the speed of the accumulation of Sucrose. Its maximum effectiveness was coincided with the highest level of Sucrose in the *khalal* phase (early stage of yellowed fruit) followed by a decrease reached its minimum in the *tamur* (last stage of fruit) phase. Because Sucrose is the base material that the enzyme works on. On the other hand, the low water content of the fruit, which is a medium for biological reactions (enzymatic hydrolysis reactions), led to a decrease in the activity of the enzyme Invertase (Taain, 2013).

## Productive Properties

Ripening Percentage: The results shown in table 11, indicate that the treatment of *hilawi* date palm trees with different salt stress treatments gave a significant increase in the percentage of fruit ripening. The fertilized treatment (2 ml / liter of nanofed agriculture) gave the highest rate of ripening (85.030%) in comparison to the other factors under study. Whilst, the lowest ripening rate was achieved with the comparison treatment, as it reached at (60.685%) and with significant differences compared to all the treatments under study. The reason for that may be due to the role of the mineral elements in the nutrient solution to reduce the damage of salinity on the plant and the lack of water absorption Because of the osmotic stress imposed on plant roots growing in a high salinity ground as well as to the low biological activity in the soil micro-organisms (Srour *et al*., 2010). For the purpose of deterring the significant deterioration in tree growth and productivity and reduction of damage caused by salt stress, the nutritional elements are added for building DNA, RNA and energy compounds: ATP and ADP, Also, they have an entry into coenzymes NADP + and $NAD^+$ that have a fundamental role in many biological and physiological processes such as photosynthesis and respiration, which leads to an increase in the percentage of fruit ripening (Kamiab and Bahramabadi, 2016).

The method of adding salt stress treatments to *hilawi* palm trees has no significant effect in increasing the ripening percentage as stated in the table 11. The ground addition method was superior to giving the highest rate of fruit ripening (76.248%) compared to the spray method that gave the lowest ripening rate (75.833%). Results showed that the nature of the interference between treatments for salt stress and its addition methods to *hilawi* date palm trees had a significant effect on increasing the percentage of fruit ripening rate. The treatment (2 ml/ liter nano-agriculture fertilizer + ground addition) excelled in giving the highest rate of ripening (85.38%), with non-significant differences from the treatments (2 ml / liter nano-agricultural fertilizer + spray method) and (2 ml / liter organic fertilizer + ground addition) and (2 ml / liter organic fertilizer + spray method). The ripening percentage for them (84,680, 84,480 and 83,890)% sequentially, while it significantly outperformed other interference factors and the two comparative treatments

**Table 12:** Effect of salt stress treatments, addition methods and their interferences on fruit ripening percentage %.

| Rutab stage | | | |
|---|---|---|---|
| Average effect of salt stress treatments | Addition methods | | Treatments for saline stress |
| | Add spray | Add spray | |
| 17.125 | 17.17 | 17.08 | 0 |
| 14.580 | 14.22 | 14.94 | Dilzy (2ml / L) |
| 14.045 | 13.98 | 14.11 | Seamino (2ml / L) |
| 12.105 | 11.54 | 12.67 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =0.1240 | 14.228 | 14.700 | Average effect of addition methods |
| | RLSD to the effect of interference =0.2259 | | RLSD for the effect of adding methods =0.1227 |

of the spray and ground addition methods (75,833% and 76,248%) respectively. The reason for this may be due to the response of palm trees to the added treatments that led to an increase in the activity of anti-oxidant enzymes. It also has significant functions in plant metabolism, such as activating Catalase enzymes, Superoxide dismutase, photosynthesis and chlorophyll content, which was reflected positively in increasing the rate of fruit ripening (Taiz and Zaiger, 2016).

Drop Percentage (%): The results in table 12, indicate that there were significant differences between salt stress treatments in reducing the rate of fruit drop. The treatment (2 ml / liter nano-agriculture fertilizer) gave the lowest percentage of fruit drop as it reached (12.105%) while the highest rate of drop was achieved with the comparison treatment (17.125%). As for the effect of the addition method, the results showed in table 12, a significant increase in the rate of drop in the addition method of spray by (14.700%), while the rate of drop with the ground addition decreased by (14.228%). Results also showed at table 12, interference between salt stress treatments and addition methods where the treatment (2 ml / liter nano fertilizer + ground addition) exceeded significantly in reducing the percentage of fruit drop, as it reached (11.54%) compared to other interference factors under study. Whereas the highest rate of drop was achieved with comparison treatment at the spray and ground addition methods as it reached (17.08 and 17.17)%.

The reason for this may be that the treatment of *hilawi* date palm trees achieved a state of nutritional balance within the plant, which was reflected in reducing competition between fruits on nutrients and then reducing the percentage of fruit drop. Or the reason could be occurring of consistency between addition methods with salt stress treatments for *hilawi* date palm trees. It resulted in a water balance between the plant and its outer environment, thereby reducing the osmotic pressure in the plant resulting from salt stress and this was reflected positively in reducing the drop percentage (Taain, 2013).

Average Yield Rate (kg): Table 13, shows the significant effect of different salt stress treatments on the total yield of a palm trees when added to the *hilawi* palm trees where the treatment (2 ml / liter nano agricultural fertilizer) excelled in giving the highest total yield rate at (65.270 kg) compared to the comparison treatment at which the lowest total yield was achieved at (54.075 kg). The reason for this may be attributed to the increase in the average weight and size of the fruit with salt stress treatments used in the study as stated in tables (5 and 6) in respectively.

The results showed in table 13, that the addition method was affected by the total yield of *hilawi* date palm, where the ground addition excelled in giving the highest average total yield (62.09 kg) and with significant differences with the spray method at which the total yield rate reached at (60.795 kg). Increasing the total yield rate with the ground addition method for salt stress treatments in the *hilawi* palm trees could be attributed to in the *hilawi* palm trees due to the presence of a direct relationship between the average total yield and the average fruit weight (Table 5).

Table 13, shows results reflecting the effect of the interference between treatments for salt stress and the addition methods to *hilawi* date palm trees. As it was noticed, the total yield rate increased gradually with the added

**Table 13:** Effect of salt stress treatments, addition methods and their interferences on fruit ripening percentage %.

| Date stage | | | |
|---|---|---|---|
| Average effect of salt stress treatments | Addition methods | | Treatments for saline stress |
| | Add spray | Add spray | |
| 54.075 | 54.20 | 53.95 | 0 |
| 62.36 | 63.89 | 60.83 | Dilzy (2ml / L) |
| 64.065 | 64.56 | 63.57 | Seamino (2ml / L) |
| 65.27 | 65.71 | 64.83 | nanoparticle fertilizer (2ml / L) |
| RLSD for the effect of stress treatments =0.5277 | 62.09 | 60.795 | Average effect of addition methods |
| | RLSD to the effect of interference =0.9733 | | RLSD for the effect of adding methods =0.3862 |

salt stress treatments. And the best significant increase in the total yield rate was given by the treatment (2 ml / liter of Nano agricultural fertilizer + ground addition by 65.71 kg) compared to the other treatments under study. All the added treatments during the two methods of addition by spray and ground significantly outperformed the comparison treatment (distilled water + spray) and (distilled water + ground addition) by (53.95 and 54.20) consequentially. This may be attributed to the fact that the treatment of *hilawi* date palm trees with salt stress treatments during the cell division and growth period led to an increase in the osmotic pressure of the cells as a result of the penetration of the added nutrients into them. This phenomenon led to an increase in the absorption of water and other nutrients into the treated fruits and then increasing its weight, which was reflected in the increase in the average total yield of *hilawi* date palm trees (Khan *et al*., 2016).

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