

# Effect of Soaking with Seaweed Extract (Acadian) on the Qualitative Characteristics of Seedlings of Wheat Variety Tammuz Under Salt Stress

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## Abstract

A laboratory experiment was carried out in the laboratories of the Department of Seed Examination and Certification of the Ministry of Agriculture, the seed technology laboratory and the postgraduate laboratories of the College of Agricultural Engineering Sciences - University of Baghdad for the year 2021-2022, To determine the best synthesis of Acadian extract concentration (0, 1500, 2000 and 2500) mg L<sup>-1</sup>, under three stress levels (5, 10 and 15) dS m<sup>-1</sup> as well as a control treatment through laboratory and qualitative characteristics of seedlings of wheat variety Tammuz cultivar. A factorial experiment was applied according to a completely randomized design (CRD) with three replications for each treatment. The results showed that the treatment of seed soaking with seaweed extract at a concentration of (2500 mg L<sup>-1</sup>) was significantly superior in phenol and catalase enzyme without significantly different from the concentration of (2000 mg L<sup>-1</sup>). The results indicated the superiority of the soaking treatment with Acadian extract (2500 mg L<sup>-1</sup>) in the ratios of Proline, total chlorophyll, phenol, peroxidase enzyme, ratio of sodium to potassium) in giving the highest average for the aforementioned characteristics. The results showed that the salt tension level 15 dS m<sup>-1</sup> negatively affected the averages of the studied traits (proline, carbohydrates, total chlorophyll, phenol, catalase enzyme, peroxidase enzyme, ratio of sodium to potassium). The results of the interaction showed a significant superiority of the combination (0 NaCl x 2500 mg L<sup>-1</sup>) in giving the best values in the traits (total chlorophyll, sodium to potassium ratio). While the combination (10 dS m<sup>-1</sup> x 2000 mg L<sup>-1</sup>) was significantly superior in most of the studied traits (phenol, catalase enzyme, peroxidase enzyme), and the combination (5 dS m<sup>-1</sup> x 2500 mg L<sup>-1</sup>) was significantly higher in the characteristic of proline, while the combination (15 dSm<sup>-1</sup> x 2000 mg L<sup>-1</sup>) was superior in the proportion of carbohydrates. It was concluded that soaking the seeds of wheat variety Tammuz with Acadian extract reduced the effect of salinity and improved the quality characteristics by improving the efficiency of enzymes and controlling the proportion of proline. It was concluded that soaking the seeds of wheat variety Tammuz with Acadian extract reduced the effect of salinity and improved the quality characteristics by improving the efficiency of enzymes and controlling the proportion of proline. We recommend soaking the wheat seeds with seaweed extract (Acadian) at a concentration of 2000 mg L<sup>-1</sup> before planting.

## 1. Introduction

Soil and water salinity is one of the main problems faced by plant production in many irrigated areas of the world, especially in arid and semi-arid areas, as it causes a decrease in the growth and yield of plants growing in those soils due to negative effects. They include reducing the value of the water potential of cells and the occurrence of disturbances in the ionic balance, in addition to inhibiting the process of cell expansion and affecting the process of photosynthesis, and inhibition of metabolic processes and the production of reactive oxygen species that are harmful to membranes, oxidation of proteins, and inhibition of the activity of enzymes (12) and (34) and (35). One of the effects of salt stress is the accumulation of proline acid in plants growing under saline stress conditions to increase its synthesis from the amino acid glutamate, or its partial oxidation due to a decrease in the activity of the enzyme proline dehydrogenase as a regulating

factor of osmotic pressure. In addition to the role of proline acid in plant cells by scavenging oxidative free radicals by increasing the production of antioxidant enzymes (such as peroxidase and catalase...etc). It helps to get rid of the ammonium toxicity caused by the methods of inhibiting the production of proteins, also regulates the osmotic pressure between vacuoles and cytoplasm (29). In addition to producing phenols, which are one of the most important non-enzymatic antioxidants that have an effective role in removing free radicals generated during plant exposure to various stresses (23). In view of the foregoing, salinity has negative effects on plants (39) and (40), so humans have sought to mitigate these damages in several ways, including choosing salinity-resistant varieties and farming in ways that reduce the damage of salts to plants. These include treatment with marine algae extracts, which are considered a good source of active substances that can benefit in mitigating and overcoming the negative effects of salinity on plants,

which are hormones such as Auxine, Cytokinin and Gibberellic acid, in addition to amino acids (7, 25). Most of the crop seeds respond to the nutrients they are treated with, which leads to the improvement of the viability and vigor of the seeds and the improvement of the qualitative characteristics through the activation of the seeds.

The research aims to study the effect of different concentrations of sodium chloride NaCl salt on the qualitative characteristics (proline enzyme catalase, peroxidase enzyme, phenols, carbohydrates and chlorophyll) of seedlings of the wheat plant variety (Tamuz) to reduce the effect of salinity on germination and seedling growth using seaweed extract (Acadian).

## 2. Materials and Methods

A laboratory experiment was carried out to find out the best combination of soaking wheat seeds from Acadian extract (0, 1500, 2000 and 2500 mg L<sup>-1</sup>) under three salt stresses in addition to the control treatment (5, 10 and 15) dS m<sup>-1</sup>. The experiment was carried out as a factorial experiment according to a completely randomized design (CRD) with three replications for each treatment. The seeds of the variety Tammuz were used. The seeds of the variety Tammuz were obtained from the research station of the Agricultural Research Department - the Ministry of Agriculture, according to the recommendations of the International Seed Testing Federation (10). Samples were taken from the seeds down to the working sample, then 300 pure seeds were taken for each treatment with 100 seeds in each replicate. The seeds were sterilized with 1% sodium hypo chloride solution for 8 minutes, as indicated by Ashraf (2) and (38), then washed well with water. The concentrations under study were prepared from Acadian solutions of Canadian origin (a natural vital nutrient of plant origin containing 50% of marine algae) after dissolving 3 g of Acadian in a beaker and adding a little deionized water to it and mixing the solution using the electric mixer to dissolve the solution and homogeneity and then complete the volume to 1 liter to prepare a solution with a concentration of 1500 mg L<sup>-1</sup>, and so for the rest of the concentrations, and those seeds were distributed alternately on special germination papers with dimensions (20×30) cm and the method of rolling was used and then they were inserted into sterile and clean nylon bags to maintain their moisture, then they were placed in incubator at a temperature (25 ± 2 °C) and a humidity of 70% for eight days, which is the duration of the experiment. After the end of the germination period, the required traits were estimated.

### Studied traits

#### 1. Determination of the concentration of proline acid

Proline was determined by Bates et al. (4) using Sulfo salycilic 3% solution, acidic ninhydrin solution and glacial acetic acid, The readings

were then taken on a spectrophotometer at 520 nm wavelength using toluene solvent as a control. The readings were converted to concentrations by making a concentration curve using proline acid.

#### 2. Estimated Carbohydrate Content (%):

The seedlings content of carbohydrates was estimated by the method of phenol reagent and concentrated H<sub>2</sub>SO<sub>4</sub> acid at a wavelength of 488 nm (9). According to the following equation:

Total carbohydrates % = device sample readings x 25 x (10/sample weight) x 1000

#### 3. Chlorophyll content (mg g<sup>-1</sup> fresh weight)

It is estimated according to the Linchtenthaler method mentioned by Zhang and Kirkham (19) according to the following equation:

Chlorophyll a (mg. L<sup>-1</sup>) = 12.7D(663) – 2.69D(645)

Chlorophyll b (mg. L<sup>-1</sup>) = 22.9D(645) – 2.69D(663)

Total Chlorophyll (mg. L<sup>-1</sup>) = [20.2D(645) + 8.02D(663)]

#### 4. Determination of total phenols (µg/mg dry weight)

Phenol was estimated by Liu et al. (11) method using diluted Folin-ciocalteu reagent and sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>) 0.2% (w/v), then the optical absorption reading was taken at a wavelength of 760 nm, the readings were compared according to the regression line equation.

#### 5. Determination of the activity of the enzyme catalase (CAT)

The activity of CAT enzyme was estimated according to method (1) using buffer potassium phosphate with PH = 7.8 and hydrogen peroxide solution and using a spectrophotometer at a wavelength of 240 nm.

#### 6. Determination of the activity of peroxidase enzyme (POD):

The activity of the POD enzyme was estimated according to the Nezh method (15). This method was carried out using the rate of hydrogen peroxide decomposition by the POD enzyme with hydrogen-donating quaycol. It was determined by measuring the rate of color development using a spectrophotometer at a wavelength of 436 nm.

Enzymatic activity (uptake unit. gm sample<sup>-1</sup>) = (device reading) / (sample weight/extraction volume) x volume taken for reading.

#### 7. Seedling content of K<sup>+</sup>, Na<sup>+</sup> ions:

The content of seedlings of sodium and potassium ions was estimated using a flame photometer according to the method (5). The samples were digested using concentrated sulfuric acid and perchloric acid HClO<sub>4</sub>.

## 3. Results and Discussion

### 1. Proline seed content (µg ml<sup>-1</sup>)

The ability of the plant to tolerate salinity and drought is related to its ability to accumulate

proline acid in its tissues when exposed to these conditions (17) and (33). The results showed an increase in the proline content of the seed with an increase in saline concentrations, as the concentration (5 dS m<sup>-1</sup>), which did not differ significantly with the concentration (10 dS m<sup>-1</sup>) and the concentration (15 dS m<sup>-1</sup>), was superior. The mean was 0.449 µg ml<sup>-1</sup> compared to the control treatment, which gave the lowest average amounted to 0.360 µg ml<sup>-1</sup> (Table 1). This may be due to the fact that proline acid increases with increasing salt concentrations, as it works to modify the osmosis between the vacuole and the cytoplasm of the cell. It begins to accumulate in the cytoplasm after entering NaCl and collect monovalent ions in the vacuoles. It also works to draw water from the saline medium to reduce the toxicity of ions at high salt concentrations, in addition to its effect on protecting enzymes and cellular organelles (13).

The results indicate that there were significant differences in this trait with an increase in Acadian extract concentrations, as the concentration (2500 mg L<sup>-1</sup>) gave the highest mean of 0.490 µg ml<sup>-1</sup> compared to the control treatment which gave the lowest average of 0.310 µg ml<sup>-1</sup>. This is consistent with (24). Perhaps the reason for the increase in proline acid when treating seeds with extracts of marine algae, which is a good source of active substances that can benefit in mitigating and overcoming the negative effects of salinity on the plant (25, 28).

The results also showed that there was a significant interaction between the salt concentrations and the concentrations of Acadian extract, as the combination (0 NaCl x control treatment) gave the lowest prolin content (0.244 µg ml<sup>-1</sup>), compared to the combination (5 dS m<sup>-1</sup> x Acadian 2500 mg L<sup>-1</sup>), which gave the highest mean of 0.570 µg ml<sup>-1</sup> (Table 1).

**Table 1. Effect of soaking with Acadian extract and NaCl concentrations of Tammuz wheat variety and the interactions between them on the seedling content of proline (µg ml<sup>-1</sup>)**

NaCl (dS m <sup>-1</sup> )	Acadian extract (A) (mg L <sup>-1</sup> )				NaCl mean
	0	1500	2000	2500	
0	0.244	0.320	0.404	0.471	0.360
5	0.306	0.399	0.520	0.570	0.449
10	0.332	0.425	0.490	0.519	0.441
15	0.359	0.370	0.390	0.399	0.379
LSD <sub>N×A</sub>	1.46				LSD <sub>N</sub>   0.73
Acadian mean	0.310	0.378	0.451	0.490	
LSD <sub>A</sub>	0.073				

## 2. The content of soluble carbohydrates in the seedlings (%)

The results indicate an increase in the soluble carbohydrate content of the seed with an increase in salt concentrations, as the concentration (15 dS m<sup>-1</sup>) was significantly superior to the rest of the concentrations, reaching 93.50%, while the lowest average was with control treatment was 91.69%

(Table 2). This may be due to the fact that the rate of carbohydrates increases with an increase in salt concentrations because salinity reduces the ability and efficiency of cells to convert simple sugars into complex sugars. Thus, one of the defensive means for the cell to raise its tolerance to salt stress is to increase the amount of dissolved sugars to increase osmosis and thus these organic compounds will work to plays an important role in tolerating salinity, as it works with proline to raise the osmotic potential in the cell (8).

The results also showed significant differences in the concentrations of Acadian extract, as the concentration (2500 mg L<sup>-1</sup>) gave the highest mean of 93.53% compared to the control treatment which gave the lowest mean of 91.80%. The results agree with (30). The reason for the increase in the proportion of carbohydrates in the seedling content may be due to the positive role of seaweed extract in improving vegetative growth and qualitative characteristics in many crops, because it contains nutrients, amino acids, polysaccharides, and plant growth hormones such as cytokinin, auxin, and gibberellin (21) and (37). Because of the extreme importance of carbon in the synthesis of carbohydrates, as well as the elements of oxygen and hydrogen, and that acadian fertilizer may have caused an increase in this element along with the two elements of oxygen and hydrogen, which increased the averages of photosynthesis and building carbohydrates and the transfer and accumulation of those elements in the seeds.(36)

**Table 2. Effect of soaking with Acadian extract and NaCl concentrations of Tammuz wheat variety and the interactions between them on the content of soluble carbohydrates in the seedlings (%)**

NaCl (dS m <sup>-1</sup> )	Acadian extract (A) (mg L <sup>-1</sup> )				NaCl mean
	0	1500	2000	2500	
0	0.244	0.320	0.404	0.471	0.360
5	0.306	0.399	0.520	0.570	0.449
10	0.332	0.425	0.490	0.519	0.441
15	0.359	0.370	0.390	0.399	0.379
LSD <sub>N×A</sub>	LSD <sub>N×A</sub>				0.92   LSD <sub>N×A</sub>
Acadian mean	91.80	92.19	93.29	93.53	
LSD <sub>A</sub>	0.46				

The results also showed a significant interaction between saline concentrations and Acadian extract concentrations, as the combination (15 dS m<sup>-1</sup> x Acadian 2000 mg L<sup>-1</sup>) gave the highest mean for the characteristic that reached 93.86% compared to the combination (0 NaCl x 0 Acadian), which gave the lowest mean of 90.62%.

## 3. Total chlorophyll content in the seedling (mg<sup>-1</sup> fresh weight)

High concentrations of sodium chloride work in a negative direction on the photosynthesis process by affecting the exact structure of chloroplasts, as the membranes of these organelles shrink with distortion of the chlorophyll-bearing membrane plates. So that the concentration of the dye decreases at high levels

of salinity, and this is due to the lack of absorption of the necessary elements to build the chlorophyll molecule (32). The results showed that there was a significant effect on the seedling content of total chlorophyll by increasing the concentrations of sodium chloride salt, as the concentration (15 dS m<sup>-1</sup>) gave the lowest mean of 45.51 mg<sup>-1</sup> fresh weight compared to the rest of the concentrations and the control treatment. These results are in agreement with the study (14) and Al-Zuwaini (26) on the wheat plant, which showed a decrease in the chlorophyll content in the leaves, as the highest rate of chlorophyll was in the lowest average of sodium chloride.

The results indicate that there were significant differences in this trait, and the best results were obtained from the treatment of soaking Acadian extract at a concentration (2500 mg L<sup>-1</sup>), which gave a maximum average of 80.63 mg<sup>-1</sup> wet weight compared to the untreated seeds, which gave the lowest average of 54.92 mg<sup>-1</sup> fresh weight. This is consistent with the results (18) that spraying seaweed extract with a mixture of amino acids improved the growth characteristics of rice and gave the highest root wet and dry weight, chlorophyll a, chlorophyll b and total chlorophyll content.

The results also showed a significant interaction between saline concentrations and Acadian extract concentrations, as the combination of (0 sodium chloride x Acadian 2500 mg L<sup>-1</sup>) gave the highest mean for the character 108.90 mg<sup>-1</sup> fresh weight compared with the combination (15 dS m<sup>-1</sup> x soaking in deionized water), which gave the lowest mean for the character was 36.98 mg<sup>-1</sup> fresh weight (Table 3).

NaCl(dS m <sup>-1</sup> )	Acadian extract (A) (mg L <sup>-1</sup> )				NaCl mean
	0	1500	2000	2500	
0	76.29	81.89	97.05	108.90	91.03
5	61.42	73.97	87.77	93.47	79.16
10	45.01	53.28	61.04	64.09	55.86
15	36.98	39.68	49.31	56.07	45.51
LSD <sub>N*A</sub>	10.84				LSD <sub>N</sub> 5.42
Acadian mean	54.92	62.20	73.79	80.63	
LSD <sub>A</sub>	5.42				

#### 4. The percentage of phenol in the seedlings (µg ml<sup>-1</sup>)

The results showed an increase in the phenol content of the seedling with an increase in saline concentrations, as the concentration (15 dS m<sup>-1</sup>) was significantly superior to the rest of the concentrations, as it gave an average of 863.8 µg ml<sup>-1</sup>, while the lowest average was when the control treatment was 698.1 µg ml<sup>-1</sup> (Table 4).

The results showed that there were significant differences in the trait with an increase in the concentrations of Acadian extract, as the concentration (2500 mg L<sup>-1</sup>) gave the highest mean of 885.5 µg ml<sup>-1</sup> compared to the control treatment,

which gave the lowest average of 779.1 µg ml<sup>-1</sup>. The reason for the increase in the proportion of phenols in seedlings may be due to the fact that the marine algae extract contains natural phenols such as (tannins), which have a great role as anti-bacterial and anti-fungal and at the same time play a similar role to natural growth hormones and improve the formation of the embryo in plants, which increases their tolerance to diseases, in addition to the properties of phenols as it works to prevent the formation of free radicals and the formation of more stable compounds, this is because of its structure (22).

The results also showed a significant interaction between the salt concentrations and the concentrations of Acadian extract, as the combination (10 dS m<sup>-1</sup> x Acadian 2000 mg L<sup>-1</sup>) gave the highest mean for phenol that reached 919.4% compared to the combination (0 NaCl x 0 Acadian), which gave the lowest mean of 668.3%.

NaCl (dS m <sup>-1</sup> )	Acadian extract (A) (mg L <sup>-1</sup> )				NaCl mean
	0	1500	2000	2500	
0	668.3	704.0	707.2	712.9	698.1
5	694.4	727.0	878.9	820.2	780.1
10	753.0	804.2	919.4	900.1	844.2
15	859.6	862.6	867.9	864.9	863.8
LSD <sub>N*A</sub>	133.2				LSD <sub>N</sub> 66.6
Acadian mean	743.8	774.5	843.4	824.5	
LSD <sub>A</sub>	66.6				

#### 5. The percentage of catalase enzyme in the seedling (AU. gm<sup>-1</sup>. fresh weight)

The results indicate a difference in the seedling content of catalase enzyme by increasing the saline concentrations, as the concentration (10 dS m<sup>-1</sup>) was significantly superior to the rest of the concentrations, as it gave the highest average of 0.061 absorption units. The control treatment was 0.027 AU.gm<sup>-1</sup>. fresh weight (Table 5), This is consistent with what was mentioned (16). The reason for the increase in the peroxidase enzyme may be due to the increase in salt concentrations, as it is one of the defense systems against environmental stresses that stimulates the oxidative potential represented by increasing the formation of free radicals (ROS) harmful to plants, whose production increases when the cell is exposed to stress, as the catalase enzyme works to get rid of them through Hydrogen peroxide removal (6), and these oxygen radicals are found in certain components of the cell, such as chloroplasts (peroxisomes and clixisomes) and cytoplasm (20).

The results also indicate that there were significant differences in this trait with an increase in the concentration of Acadian extract, as the concentration (2000 mg L<sup>-1</sup>) gave the highest average of 0.058 AU gm<sup>-1</sup>. fresh weight without

significantly different from the concentration (2500 mg L<sup>-1</sup>), which gave an average of 0.057 AU gm<sup>-1</sup>. fresh weight, while the control treatment gave the lowest mean of 0.024 AU gm<sup>-1</sup>. fresh weight. The reason for the increase in the enzyme catalase may be attributed to the role of the Acadian extract, which acts as an antioxidant by increasing the activity of some enzymes such as catalase and peroxidase (3).

The results also showed that there was a significant interaction between the salt concentrations and the concentrations of Acadian extract (Table 5), as the combination (10 dS m<sup>-1</sup> x Acadian 2000 mg L<sup>-1</sup>) gave the highest mean for the characteristic that reached 0.084 AU gm<sup>-1</sup>. fresh weight compared to the combination (0 NaCl x 0 Acadian), which gave the lowest mean for the character was 0.008 AU gm<sup>-1</sup>. fresh weight.

NaCl (dS m <sup>-1</sup> )	Acadian extract (A) (mg L <sup>-1</sup> )				NaCl mean
	0	1500	2000	2500	
0	0.008	0.011	0.044	0.045	0.027
5	0.014	0.017	0.047	0.048	0.032
10	0.032	0.046	0.084	0.081	0.061
15	0.042	0.042	0.056	0.054	0.048
LSD <sub>N*A</sub>	0.023				LSD <sub>N</sub>   0.011
Acadian mean	0.024	0.029	0.058	0.057	
LSD <sub>A</sub>	0.011				

## 6. Peroxidase enzyme percentage in the seedling (AU gm<sup>-1</sup>. fresh weight)

The seed content of the enzyme increased with the increase in salt concentrations, as the concentration (10 dS m<sup>-1</sup>) was significantly superior to the rest of the concentrations (0.928 AU gm<sup>-1</sup>. fresh weight (Table 6), and this agrees with (16), the reason for the increase of peroxidase enzyme in the seedling may be due to an increase in salt concentrations, as it is one of the defense systems against environmental stresses that stimulate the oxidative stress represented by increasing the formation of free radicals (ROS) that are harmful to plants, which its production increases when the cell is exposed to stress, as the peroxidase enzyme works to get rid of it by removing hydrogen peroxide (6).

The results indicated that there were significant differences in this trait with an increase in the concentrations of Acadian extract, as the two concentrations (2000 and 2500 mg L<sup>-1</sup>) gave the highest mean of 0.877 AU g<sup>-1</sup>. fresh weight, compared to the control treatment, which gave the lowest average of 0.686 AU gm<sup>-1</sup>. fresh weight. The reason for the increase in the enzyme peroxidase may be attributed to the role of Acadian extract, which acts as an antioxidant by increasing the activity of some enzymes, catalase and peroxidase (3).

NaCl (dS m <sup>-1</sup> )	Acadian extract (A) (mg L <sup>-1</sup> )				NaCl mean
	0	1500	2000	2500	
0	0.436	0.405	0.697	0.753	0.573
5	0.658	0.788	0.829	0.877	0.788
10	0.795	0.918	1.027	0.972	0.928
15	0.855	0.876	0.954	0.907	0.898
LSD <sub>N*A</sub>	0.247				LSD <sub>N</sub>   0.123
Acadian mean	0.686	0.747	0.877	0.877	
LSD <sub>A</sub>	0.123				

The results also showed a significant interaction between the salt concentrations and the concentrations of Acadian extract, as the combination (10 dS m<sup>-1</sup> x Acadian 2000 mg L<sup>-1</sup>) gave the highest mean for the character that reached 1.027 AU gm<sup>-1</sup>. fresh weight compared to the combination (0 NaCl x Acadiane 1500 mg L<sup>-1</sup>), which gave the lowest mean for the character was 0.405 AU.gm<sup>-1</sup>. fresh weight.

## 7. The ratio of potassium ion to sodium ion in the seedlings

The results showed a decrease in the seed content of the ratio between the two elements potassium to sodium with an increase in saline concentrations, as the concentration (15 dS m<sup>-1</sup>) gave the lowest average for the trait amounted to 0.50%, while the highest average was at the control treatment 3.22% (Table 7). Results with the results of Al-Naimi (2015). The reason for this is that plants under natural conditions maintain a high level of the ratio of potassium to sodium due to its importance in the biochemical processes of plant cells. The high concentration of potassium ions attributed to the sodium ions in the cell cytosol, which cells depend on to ensure continued absorption of water and dissolved substances (27).

The results showed that there were significant differences in this trait by increasing the concentrations of Acadian extract, as the concentration 2500 mg L<sup>-1</sup> gave the highest mean of 2.22% compared to the control treatment which gave the lowest mean of 0.85%.

The results indicated that there was a significant interaction between the salt concentrations and the concentrations of Acadian extract, as the combination (0 NaCl x Acadian 2500 mg L<sup>-1</sup>) gave the highest mean for the character reached 5.12% compared to the combination (15 dS m<sup>-1</sup> x soaking with distilled water) which gave the lowest mean of 0.42%.

## 4. Conclusions and Recommendations

We conclude that soaking wheat (var. Tawmuz) seeds with Acadian extract reduces the effect of salt stress and increases the viability of the seeds by improving

the quality characteristics of the seeds and seedlings resulting from them. We recommend soaking wheat seeds at a concentration of 2000 mg L<sup>-1</sup> before planting.

**Table 7. Effect of soaking with Acadian extract and NaCl concentrations of Tammuz wheat variety and the interactions between them on the Na+K+ ion in the seedlings**

NaCl(dS m <sup>-1</sup> )	Acadian extract (A) (mg L <sup>-1</sup> )				NaCl mean
	0	1500	2000	2500	
0	1.816	2.387	3.590	5.123	3.229
5	0.731	1.232	1.339	1.992	1.324
10	0.444	0.589	0.796	1.190	0.755
15	0.426	0.448	0.534	0.605	0.503
LSD <sub>N<sup>a</sup></sub>	0.184				LSD <sub>N</sub> 0.092
Acadian mean	0.854	1.164	1.565	2.227	
LSD <sub>A</sub>	0.092				

We recommend conducting similar studies with different concentrations on other varieties of wheat and on other types of crops to know the effect of seed stimulation with seaweed extract (Acadian). We also recommend conducting more studies with other biological extracts.

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