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Effect Of Salinity on Seed Germination and Growth of Some Wheat

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تأثير الملوحة على إنبات البذور ونمو بعض أصناف القمح

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Abstract:
In a study to identify the morphological and physiological traits of wheat cultivars that are the most salt-tolerant in response to salinity, we have analyzed how salinity influences the morphological and physiological traits of select wheat cultivar in the germination and growth phases of wheat in the Al-Marj city. We have chosen two types of wheat: Triticum monococcum and Triticum araratica. And there exist two concentrations of 30-60 ×(103ppm) besides the control ente which the results obtained indicated that salt stress was non-selective on germination of all varieties studied under the different criteria studied particularly at high levels 60 ×(103ppm). The closest resembling the models, like the examined Triticum. arraraticum, did not respond to salt stress, like Triticum monococcum.

Keywords: Varieties, salinity, wheat, salt stress, germination, morphological parameters, physiological parameters.

الملخص:
في دراسة هدفت إلى تحديد الصفات المورفولوجية والفسيولوجية لأصناف القمح الأكثر تحمّلًا للملوحة، تم تحليل تأثير الإجهاد الملحي في بعض الصفات المورفولوجية والفسيولوجية لعدد من أصناف القمح خلال مرحلتي الإنبات والنمو في مدينة المرج. وقد تم اختيار نوعين من القمح هما Triticum monococcum وTriticum araratica. واستُخدمت معاملتان ملحيتان بتركيزين 30×10^3 و60×10^3 جزء في المليون، إضافة إلى معاملة المقارنة (الشاهد). أظهرت النتائج أن الإجهاد الملحي لم يُظهر تأثيرًا انتقائيًا في نسبة إنبات جميع الأصناف المدروسة وفق المعايير المختلفة المعتمدة في الدراسة، ولا سيما عند التركيز المرتفع 60×10^3 جزء في المليون. كما بيّنت النتائج أن النمط الوراثي المدروس من T. araratica لم يُبدِ استجابة واضحة للإجهاد الملحي، على نحو مماثل لما لوحظ في T. monococcum.

الكلمات المفتاحية: الأصناف، الملوحة، القمح، الإجهاد الملحي، الإنبات، المعايير المورفولوجية، المعايير الفسيولوجية.

Introduction:

Wheat is ranked among the most significant food crops in the world since it is regarded as the initial and primary source of human food in all countries worldwide since it has a very high proportion of protein, which makes the flour of this wheat of high quality and nutrition value (Alam, *et al* 1990). It covers the greatest area of cultivated land relative to crops because it is highly adaptive to temperate climates (Balhais, 2014). Being the major cultivator of the field crops in the global terms (around 712 million hectares of land are cultivated all over the world) its production reaches up to 476 tons (FAO, 2015). Agriculture in the southern areas (the desert) of Algeria and modern agriculture in particular, requires irrigation systems and the dry climate and high temperature are common (Ferjani and Talbi , 2019). Although the irrigation water in such places is salty, it is a compulsory alternative because it has very little water sources. It is important to be aware that the salt content of the soil will be deposited in the root zone due to irrigation by saline water to some degree after which the adverse effects of the salt on plant growth start by increasing the osmotic pressure of the soil solution, which acts to suppress the capacity of the roots to take in water (Al-Zuwaik , 2010). Over the years, large portions of tillable land have been changed to unsuitable land, due to the deposition of salts in the soil till it now becomes unsuitable to the growth of most of the plants, because of the amount of salts deposited in some of the water used to irrigate the soil, the most important of which is the sodium chloride (Marschner, 1998). Germination is a significant phase in the successful crop growth and production because researchers use it to choose the species and their resistance to different environmental stresses (Zaghdi and Masai, 2019). The impact of salts on plant development, its harm, and resistance to salts has attracted the attention of many scientists (Bouchama and Boukazakh, 2014).

MATERIALS AND METHODS:

Study objective:

This study seeks to determine the impact of two salinity levels that are caused by the sodium chloride on the germination vigor and early growth of two local varieties of durum wheat. It is intended to find out the tolerance of each variety to the salt stress, thus informing on the choice of the best varieties to cultivate in salinity-prone regions in Libya.

Experimental Site:

Laboratory No. (3), Department of Botany, Faculty of Science, University of Derna, Libya carried out the experiment.

Plant Material:

In this study two local varieties of durum wheat were utilized which were collected at Marj region of Libya as indicated in the table below:

Table (1): Classification of wheat types

Local name	Scientific name	Geographic origin	Scientific abbreviation
Single wheat	Triticum Monococcum)	Marj city	TM
Turanian Khorasan wheat	Triticum.araraticum	Marj City	TA

TA

TM

Figure (1): Wheat varieties**.**

Experimental Completion Phase:

Seed Preparation: The seeds were picked out of the spikes by hand and 150 healthy seeds of each variety were chosen. Fifty seeds of each variety were weighed and the average initial weight determined. To stabilize the seed, it is recommended to place it in a solution of 1.5 parts NaCl to 1.0 part HCl until it becomes unattractive to birds and predatory insects

Seed Sterilization and Imbibition:

The seeds were placed in 5ml water and bleach solution (5 ml/150 ml water) over a period of 5 minutes. The seeds were then mixed in a purified water and allowed to imbibe the water after 4 hours.

(a): Imbibe the seeds (b): Prepare a solution of water+ bleach to sterilize the seeds.

Figure (2): The stages of seed sterilization.

Seed cultivation:

Distribution of seeds- The paper towels in Petri dishes were saturated with saline solutions and then used to distribute the seeds. A variety of dishes was used per each variant (3 dishes per concentration: 0, 30 and 60 mmol/L). Sowing of seeds Ten seeds sown in each dish.

Preparation of saline solutions:

Two sodium chloride solutions (30 and 60 mmol/L) were made by adding the relevant amounts of sodium chloride to 100 ml of distilled water using a magnetic stirrer.

Figure(3): Weigting NaCl

Criteria studied:

Physiological criteria:

Soaking percentage (%): Based on the difference between seed weight before and after soaking (Almansouri *et al*, 2001):

$$\frac{\text{Seed weight after imbibition} - \text{seed weight befor imbibition}}{\text{Seed weight befor imbibition}} \times 100$$

Germination percentage (%):

According to (Kandi *et al*, 2012), the germination percentage is calculated as follows:

$$P= \frac{\text{Number of fixed seeds (NG)}}{\text{Total number of seeds (N)}} \times 100$$

Where:

P: Germination percentage.

NG: Number of germinated seeds.

N: Total number of seeds.

Germination vigor index:

According to the germination vigor index is calculated as follows:

$$\frac{\text{Final germination percentage}}{\text{Seedling lenth}} \times 100$$

Consumption of stored material:

the difference between the weight of the grain before and after germination: (Soltner *et al*,1990)

$$\frac{\text{Seed weight after germination} - \text{seed weight befor germination}}{\text{Seed weight befor germination}} \times 100$$

Morphological criteria:

- Number of roots: The number of roots exceeding 1 cm in length.
- Radicle length (LR): Measurement of the longest main root.

• Pedicel length (LC): Measurement of the primary stem.
• Seedling length (PL): The sum of the root and petiole lengths.
• Seedling weight (PS): The seedling was weighed using a sensitive balance.

RESULTS:

- Morphological criteria

Number of roots:

The obtained results, which are illustrated in Table (2), show the number of roots of the studied varieties (TA; TM) when they are exposed to salt stress at both levels. We observe that there is a negative influence by 12FBC salt stress to the number of roots of the studied varieties, with the higher the concentration of NaCl, the lower the number of roots in the varieties. The number of roots had the highest value of TA variety which was 4 at C3 concentration TA variety and C3 in TM variety and the lowest value was approximated to be 3 at C6 and C6 at TM variety.

Table (2): Number of roots of the studied wheat species at different concentrations.

TA			TM			
Cn	Cn	Cn	C6	C3	Cn	
5	5	5	3	4	5	Number of roots

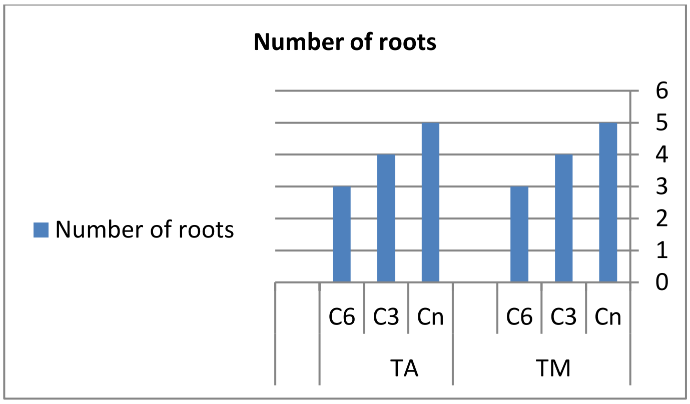

Figure (4): A graph of the number of roots in the two types of wheat studied.

Root Length:

We were able to take the measurements of the root length of the experimental wheat varieties at two levels of salinity to come up with the results as provided in Table (3). We found that stress of salt adversely influenced both varieties (TA and TM) of root length. The larger the salinity level, the shorter would be the root length. We obtained the maximum value in the TM variety, 3.5 at C3 and minimum value in the TA variety, 1.9 at C6.

Table (3): Root length of the studied wheat species at different concentrations.

TA			TM			
Cn	C3	C6	C6	C3	Cn	
5	5	5	2,1	3,5	4,5	Root length

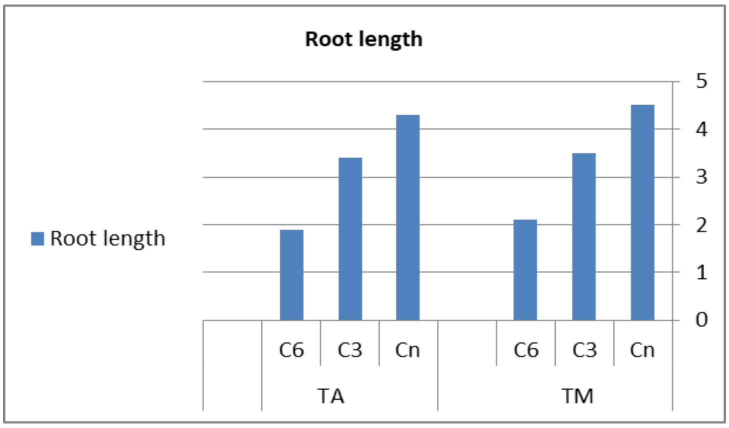

Figure (5): Root length diagram for the two studied wheat types.

Stem Length:

We measured the stem length of the investigated varieties of wheat at two salinity levels and got the results presented in Table (4). We have found that salt stress had a negative impact on stem length of the (TA.TM) varieties. Stem length was reduced with increase in salinity concentration particularly with the two TA varieties. Our maximum concentration was 4.2 in the FTM variety, at the concentration C3, and the minimum concentration was 2.6 in the same variety, TA, at the concentration C6.

Table (4): Stem length of the studied wheat species at different concentrations

TA			TM			
C6	C3	Cn	C6	C3	Cn	
2,6	3,9	5,2	3,9	4,2	5,6	Root length

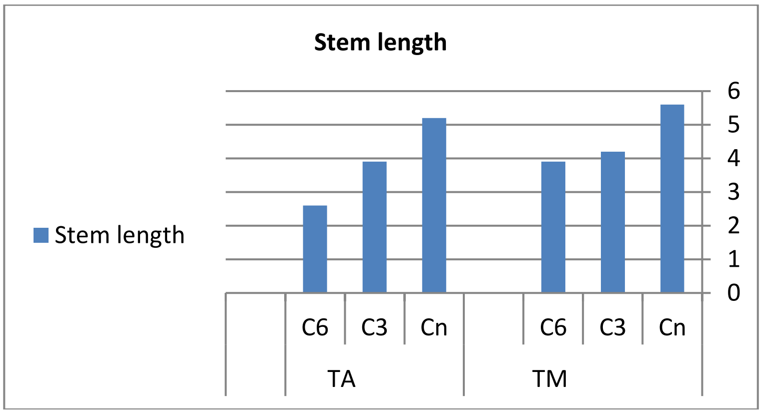

Figure (6): Stem length diagram for the two studied wheat types.

Seedling Length:

Using the measured seedling length of the studied wheat varieties at two levels following the salt stress, we got the following results as is in Table (5). We have been able to observe variations in seedling length under the various concentrations of the various varieties studied and seedling length was seen to be decreasing with increased intensity of NaCl. Our maximum reading of 7.8 when the concentration was C3 and minimum reading of 0.5 when the concentration was C6 was in the case of the TM variety.

Table (5): Seedling length of the studied wheat species at different concentrations.

TA			TM			
C6	C3	Cn	C6	C3	Cn	
4,5	7,3	9,5	0,5	7,8	10,1	**Seedling length**

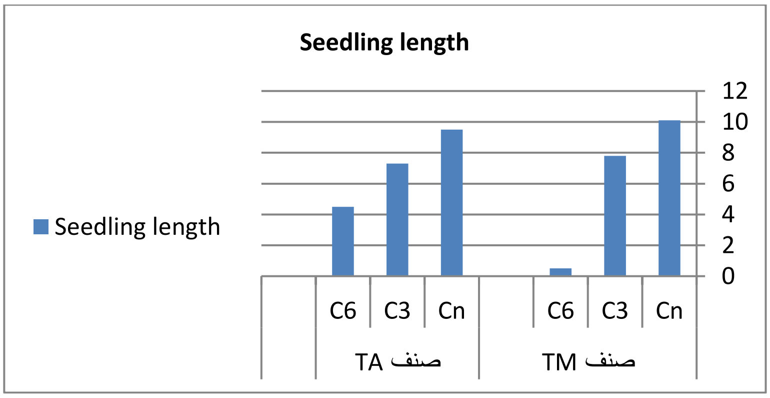

Figure (7): A diagram of the length of the cold in the two types of wheat studied.

Physiological criteria:

Germination percentage:

Having determined the percentage germination of the investigated varieties under the influence of the different concentrations 5 days after the planting day, we have obtained the results presented in Table (6), which are relative circles in the germination percentage of the investigated wheat varieties in the media with the various salt stress levels. We observe that the percent germination was high at C3 and C6 concentration of the studied varieties TM and TA, and reduced significantly at C3 concentration particularly the TM variety especially the TM variety, whereas in C6 concentration the rate of germination declined significantly in both varieties.

Table (6): Germination percentage of the studied wheat types at different concentrations.

TA			TM			
C6	C3	Cn	C6	C3	Cn	
55	80	92	60	85	95	**Germination percentage**

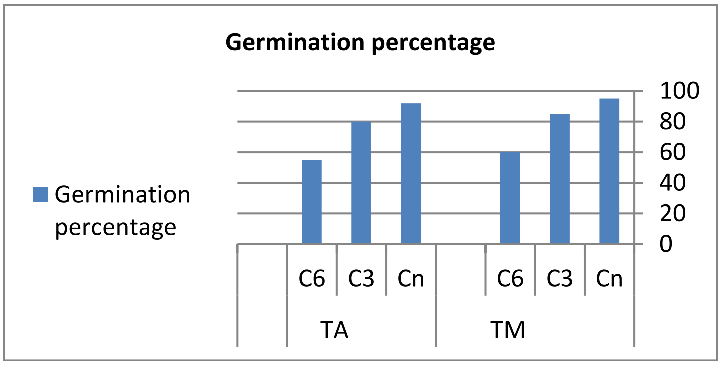

Figure (8): Germination percentage chart between the two types of wheat studied

Imbibition:

When the weight of the wheat grains of the studied varieties was taken before and after imbibition, the results were as shown in Table (7), with the wheat grains being 12% imbibitioned for the (TM) variety and 8% for the (TA) variety.

Table (7): Values before and after imbibition and the difference in imbibition for the studied wheat varieties at different concentrations.

TA	TM	Type
0.30	0.20	Before imbibition
0.38	0.32	After imbibition
8%	12%	Defference in imbibition

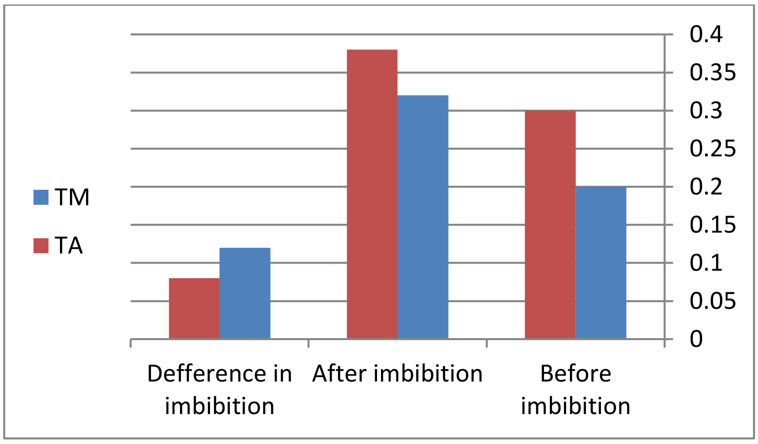

Figure (9): A chart showing the difference in absorption before and after absorption.

Consumption of Saving Material

We measured the seeds before and after the germination stage and then gave the results as shown in Table (8). The weight of the seeds reduced greatly following the germination rate at the C6 concentration particularly when it came to TM variety. Upon the introduction of C3 salinity concentration in the studied variety after germination we noted an incremental measure of seed weight as against the C6 concentration of the control. This means that salt stress did have a direct influence on seed weight following germination with the maximum value being 24.7in the TM variety and the minimum value being 17.2 in the TA variety at the concentration C6.

Table (8): Seed weight before and after germination for the studied wheat species at different concentrations**.**

TA			TM			
C6	C3	Cn	C6	C3	Cn	
17,2	23,6	29,4	18,1	24,7	30,2	Consumption of Saving Material

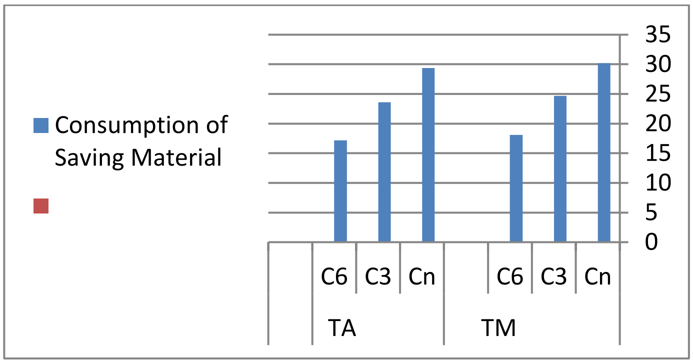

Figure (10): Scheme of the consumption of the stored material for the studied wheat types at different concentrations**.**

Germination Vigor Index:

By analyzing the results shown in Table (9), we note the highest percentage of 17.3% for the TM variety at C3 concentration and the lowest value for the TA variety at C6 concentration of 10.2%.

Table (9): Germination Vigor Index for the wheat varieties studied at different concentrations.

TA			TM			
C6	C3	Cn	C6	C3	Cn	
10,2	15,9	19,8	11,5	17,3	20,5	Germination vigor index

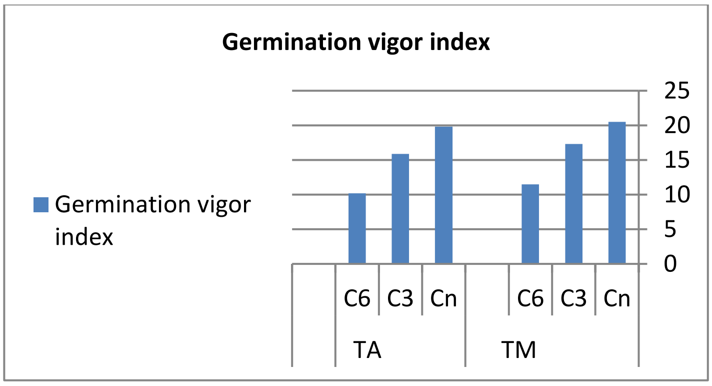

Figure (11): A diagram of the germination strength of the two types of wheat studied.

Water Content:

We then got the percentage of water content which was recorded in Table (10). We observe that the percentage of water content in all the varieties reduces at various concentrations. Salinity had adverse impact on the percentage of water content. The salinity level in the medium is higher, the lower the water content of the plant. The highest value of 76.8 was observed in the TM variety at C3 and the lowest 68.7 was observed in the TA variety at C6.

Table (10): Water content of the studied species at different concentrations

TA			TM			
C6	C3	Cn	C6	C3	Cn	
68,7	75,4	81,3	70,3	76,8	83,3	Water content

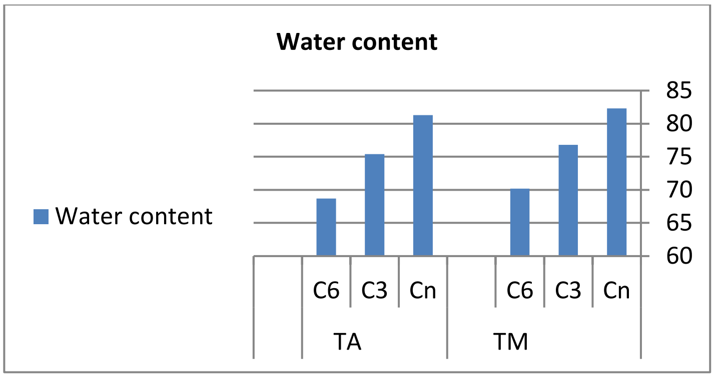

Figure (12): A diagram of the water content in the two types of wheat studied.

Discussion:

We show that the germination rate of the varieties decreases with salt stress that goes up and reaches almost zero at high salinity levels up to 60x10 ppm, which is toxic to salt-causing ions like sodium, as shown by (Awinat and Hamel, 2018) that the levels of the latter ion in the seed will be absorbed or accumulated and will affect the vital activities of the embryo and seed. As noted in (Oulmi, 2015), salt stress has a substantial impact on the initial phase of the plant (germination - seedling), and most seeds are mostly sown on highly saline soils, as the seeds cannot absorb the required amount of water to spread in the presence of salty concentrations, and the good positioning of the seedlings under stressful environments is also largely dependent on the genetic capacity of the variety to survive stress. (Bouchama, 2014) observes a reduction in the germination rate to the salinity which increases the osmotic potential of the growth medium which causes a reduction in the amount of water that is available to be absorbed by the seeds. This prevents the seed to receive adequate supply of water that results in failure or delayed germination. Salinity according to (Hassasa, 2019) acts to reduce seed germination rate. This depends on the level of saltiness of the medium directly. Salinity also affects germination adversely to the extent that it induces slow or non-germination at one stage. It can be attributed to the impact of salinity on increasing osmotic pressure of the growing environment, which inhibits the uptake of water (Awinat and Hamel, 2018). It is also important to note that the growth cannot be viewed as full until the root length reaches 1 cm or more, which (Jalabi and Mahli, 2020; Hassasa and Sweid, 2019) indicate.

This variation in the rate of absorption between varieties is due to the fact that the ability of the seed to absorb water is determined by a number of significant factors such as permeability of the seed coats to water, availability of water in the medium which the seed is immersed in and also the temperature of the medium or the environment. Our results indicate that the rate of water uptake by the seed is enhanced by the environmental temperature, and the quantity of water demanded by the seed varies with its genome (Jalabi and Mahli, 2020).

Conclusion:

The experiment was done on two cultivars of durum wheat *Triticum araraticum* and *Triticum monococcus*. The purpose of the study was to determine how salinity (NaCl) affects seed germination and growth. There were morphological parameters measured, which were the root number and length, the length of the shoot and seedling, physiological parameters measured, which included the germination percentage, absorption efficiency, the germination vigor, and nutrient consumption. The outcome of the several parameters of morphology examined revealed that the efficiency of growth and germination of the wheat varieties studied was adversely affected by salinity which was reflected on the range of parameters examined (number and length of roots, length of seedling and stalk) with the TM variety exhibiting high growth efficacy under normal conditions in all the phenotypic parameters studied and that the results indicated that the TA variety was more susceptible to salt stress than other varieties. Concerning the impact of salt stress on physiological parameters, the obtained results have shown that the varieties were different in their reaction to salinity.

The findings revealed that the various saline treatments produced varying germination rates which varied with the concentration level of saline in the varieties since a reduction was evident in the rate of germination of the experimental varieties at all the applied saline levels as opposed to the control. The low germination percentage of all varieties is attributed to the negative and toxic action of salt stress on the embryonic organs and, therefore, on the germination and growth of the seeds, as it was reported in (Brahimi R, 2017), high concentrations of sodium chloride affect the seeds by restricting the ease of water absorption, and thereby the process of hydrolysis of the stored food reserves in them and, therefore, its transfer to the embryo axis is inhibited, which causes the germination process to be delayed or prevented. We observed a decrease in germination vigor of the varieties under stress. Alam *et al*. (1990) proposed that changes in enzymes and hormones, which exist in the seed, could be the reason behind this delay. Since positive outcomes have been achieved with the TM variety in reaction to salt stress.

Recommendations:

Promote the development of the *Triticom monococcus* variety since it is the most resistant to salinity of all of the studied varieties, particularly where salinity issues are a problem.

Hypothesis: In a seed improvement program, we propose hybridization of salt-tolerant variety (Tm) and the more efficient variety (TA), to produce varieties with good texture and more salt-tolerant varieties.

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