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Effect of Activation with Different Levels of Potassium Chloride on Germination Stage and Subsequent Stages in Bread Wheat (*Triticum Astiveum*)

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تأثير التنشيط بمستويات مختلفة من كلوريد البوتاسيوم على مرحلة الإنبات والمراحل اللاحقة في قمح الخبز (*Triticum astiveum*)

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Abstract:
This study was conducted in the Seed Laboratory of the Department of Crop Sciences - Faculty of Agriculture - University of Tripoli. During the agricultural season 2022-2023 AD, to study the effect of soaking in potassium chloride solution at five concentrations (0-15-20-25-30g/L) on the germination stage and seedling growth in bread wheat varieties (Bohouth 208, Bohouth 212 and Abu Al-Khair) sourced from the Agricultural Research Center Misurata. Completely randomized design (CRD) was used with three replicates of each treatment. The studied traits were (fresh weight, seed vigour, speed of germination, germination (%), the seedling length, plumule length, the radicle length). The results of the statistical analysis showed significant differences between the potassium chloride stimulation treatments and the varieties, as the variety Bohouth 212 gave the highest average germination (%) compared to the two varieties (Abu Al-Khair and Bohouth 208), respectively. Also, the variety Bohouth 212 gave the highest values for speed of germination, outperforming the two varieties (Abu Al-Khair and Bohouth 208). The variety Bohouth 208 outperformed the two varieties (Bohouth 212 and Abu Al-Khair) with the highest average plumule length. The cultivars differed significantly in the radicle length, with cultivar Bohouth 212 recording the highest average the radicle length, followed by the two cultivars (Abu Al-Khair and Bohouth 208), respectively. As for the seedling length, the results showed significant differences, with cultivar Bohouth 212 outperforming the two cultivars (Bohouth 208 and Abu Al-Khair). In addition, cultivar Bohouth 208 outperformed the two cultivars (Bohouth 212 and Abu Al-Khair) in fresh weight. As for seed vigour, cultivar Bohouth 212 was superior to the two cultivars (Bohouth 208 and Abu Al-Khair). The interaction between wheat varieties and the stimulating concentrations of potassium chloride solution was significant in terms of its effect on most of the studied traits. Wheat seeds of the (Bohouth 212) variety soaked in a concentration of 20g/L of potassium chloride solution achieved the highest values for the interaction compared to the concentration of 30g/L which gave the lowest arithmetic averages for the studied traits.

Keywords: Varieties, Concentrations, Seed vigour, Potassium chloride, Radicle.

الملخص
أجريت هذه الدراسة في مختبر البذور بقسم علوم المحاصيل - كلية الزراعة - جامعة طرابلس خلال الموسم الزراعي 2022-2023م لدراسة تأثير النقع بمحلول كلوريد البوتاسيوم بخمسة تراكيز (0-15-20-25-30جم/لتر) على مرحلة الإنبات ونمو الباذرات في أصناف قمح الخبز (بحوث 208، بحوث 212، أبو الخير) من مركز البحوث الزراعية مصراته. تم استخدام التصميم العشوائي الكامل (CRD) بثلاث مكررات لكل معاملة. وكانت الصفات المدروسة (الوزن الطازج، قوة البذرة، سرعة الإنبات، نسبة الإنبات (%)، طول الباذرات، طول الريشة، طول الجذير). وأظهرت نتائج التحليل الإحصائي وجود فروق معنوية بين معاملات التحفيز بكلوريد البوتاسيوم والأصناف، حيث أعطى الصنف بحوث 212 أعلى متوسط إنبات (%) مقارنة بالصنفين (أبو الخير وبحوث 208) على التوالي، كما أعطى الصنف بحوث 212 أعلى القيم لسرعة الإنبات متفوقاً على الصنفين (أبو الخير وبحوث 208)، وتفوق الصنف بحوث 208 على الصنفين (بحوث 212 وأبو الخير) بأعلى متوسط طول للريشة. واختلفت الأصناف معنوياً في طول الجذير، حيث سجل الصنف بحوث 212 أعلى متوسط طول للجذير، يليه الصنفان (أبو الخير وبحوث 208) على التوالي. أما بالنسبة لطول الشتلات فقد أظهرت النتائج فروقات معنوية حيث تفوق الصنف بحوث 212 على الصنفين (بحوث 208 وأبو الخير)، كما تفوق الصنف بحوث 208 على الصنفين (بحوث 212 وأبو الخير) في الوزن الطازج أما بالنسبة لقوة البذور فقد تفوق الصنف بحوث 212 على الصنفين (بحوث 208 وأبو الخير). كان للتفاعل بين أصناف القمح وتركيزات المحفزات من محلول كلوريد البوتاسيوم تأثير معنوي في معظم الصفات المدروسة حيث حققت بذور القمح من الصنف (بحوث 212) المنقوعة بتركيز 20 جم/لتر من محلول كلوريد البوتاسيوم أعلى القيم للتفاعل مقارنة بتركيز 30 جم/لتر والذي أعطى أقل المتوسطات الحسابية للصفات المدروسة.

الكلمات المفتاحية: الأصناف، التركيزات، قوة البذور، كلوريد البوتاسيوم، الجذير.

Introduction

Cereal crops are of great importance compared to other crops as they are one of the main components of the diet of most peoples of the world (Ezweek, 2008). Wheat is one of the most widespread food crops in the world, with global production currently estimated at around 600 million tons and expected to reach 850 million tons by 2030. Due to the increase in the world population, will increase the consumption of the products of this crop (FAO, 2002). The importance of wheat lies in the fact that it is the primary food for many peoples of the earth, not only now, but since the dawn of history. The golden wheat ears are a safety valve for the future when hunger is spreading in different parts of the world with food shortages, global warming, and population growth. The first challenge for the world's countries has become providing food for their people (Al-Ashbi, 2017).

Wheat is grown under different environmental conditions in the country, where it is grown in the northeastern regions under rainfed conditions, in the other areas of the northwest and centre under supplementary irrigation systems, and in the desert areas in the south under permanent irrigation systems. However, production is still low due to many biotic (diseases, pests and weeds) and abiotic (salinity - drought - etc.) pressures, and most importantly, the lack of availability of improved seeds of good varieties (Shreidi, 2016). The seed is the means of propagation and survival for plants because it is the beginning and end of life and a source of energy due to its containing nutrients (Ezweek, 2008). Seeds are considered one of the important elements for raising the level of agricultural production. This goal cannot be achieved in any crop, regardless of the amount of effort made, unless the seeds used in agriculture contain the factors of high production in their genetic composition. Such seeds must be characterized by a high percentage of germination and standing, to ensure obtaining healthy seedlings in sufficient numbers under different field conditions (Al-Huni, 1996).

Seed activation technology plays a major role in improving its performance in germination and rapid and homogeneous emergence, in addition to enhancing field establishment to obtain the optimal plant density under a wide range of environmental conditions and reducing weed competition and infection with other agricultural pests and early and homogeneous ripening, which results in reducing crop loss and increasing production (Al-Hadi, 2019). Seed technology workers use seed technology (seedpriming) (regulating slow water absorption). it has given effective results for several field crops such as wheat, yellow corn, sunflower, peas and beans. The basis of this technique is to soak the seeds with water without germination slowly, to improve their laboratory performance, i.e., improving the physiological processes that occur inside the seed and establishing it in the field under a wide range of environmental conditions (Al-Rawi, 2017).

The importance of this technology lies in accelerating the germination process (early emergence) and homogeneity of the growing plants, in addition to reducing the time difference between the emergence of the first seedling and the last seedling, and the reflection of this on the vegetative growth of plants and producing strong plants capable of withstanding stress and unsuitable environmental conditions (Iqbal *et., al.* 2015). Improving seed performance under a wide range of environmental conditions is often associated with a treatment called (priming). The basis of this is preparing the seeds with water in a controlled manner without germination occurring, and then drying them to their initial moisture, or what is known as soaking - drying using multiple mechanisms, the most important of which are:

- Seed Hydration.
- Osmo-hardening.
- Hormonal priming.

From a botanical perspective, a seed is a fertilized egg. The embryo is formed when it matures, followed by the stored food and seed coats. From an agricultural perspective, it is the unit of sexual reproduction and preservation of the species. It contains the mature embryo, which is a small plant in a dormant phase. This seed germinates when the appropriate conditions are available to form a new plant. It links two generations of the plant's life, as it transfers genetic traits from one generation to the next (Ezweek, 2008). Seed viability is an indicator of the extent to which the characteristics of a seed sample are closely related to the ability of the seed to produce seedlings and then to emerge from the soil in order to form healthy and regular-growing plants. Seed viability is an indicator of the extent to which the characteristics of a seed sample are closely related to the ability of the seed to produce seedlings and then to emerge from the soil in order to form healthy and regular-growing plants.

Also, fully emerged seedlings largely determine a high amount of grain production through many characteristics, including reducing the period from sowing (planting) until the land is completely covered with young plants, which establishes a plant cover that gives a high yield (Al-Moussawi, 2018).

The purpose of seed stimulation is to partially moisten the seed to a point where germination begins. The embryo does not grow and its parts do not appear, but rather allow the seed to absorb water, solutions or plant hormones. The metabolic processes begin before germination and until germination occurs and the seed appears, a high-water content is required to stimulate the seed and for germination to actually occur (Bradford, 1986). Seeds are stimulated by soaking them in natural or manufactured solutions that increase the seed vigour to withstand stress, as well as increase the speed and percentage of germination and give homogeneous germination (Lal *et., al.* 2018). Seed stimulation initiates the first metabolic processes of germination without reaching full germination but close to germination. The aim of seed stimulation is to increase the speed and uniformity of germination and improve seed vigor under a wide range of environmental conditions (Manonmani *et., al.* 2014). The importance of seed stimulation technology increases with the increase in environmental stresses facing the plant, as explained by (Chatterhee *et., al.* 2018). Shehzad and his colleagues (2012) noted that stimulating white corn seeds with calcium chloride solution (1%) affected the speed and percentage of germination, fresh weight, radical length and plumule. A study was conducted to stimulate white corn seeds using calcium chloride at a concentration of 4% (12 hours of soaking) and then obtain the highest germination speed in field emergence of seeds compared to the control treatment (Ramezani and Sokht-Abandani. 2011).

Kumari and his colleagues (2017) showed that calcium chloride (1%) significantly affected the germination process of yellow corn. Farooq and his colleagues (2018) indicated that stimulating sunflower seeds using calcium chloride (1%) was superior to the control treatment in most of the traits studied in the experiment.Al-Rahmani and his colleagues (2012) found through an experiment to determine the effect of salinity on the germination of barley seeds by soaking the seeds for three periods of time (3, 6, 12 hours) in a calcium chloride solution with a concentration (1%) that the seeds soaked for (6 hours) were more resistant to salt stress. Iqbal and his colleagues (2014) indicated that soaking corn seeds for (18 hours) in different solutions of (1%) potassium nitrate and 1% calcium chloride) had a significant improvement in all studied traits compared to the control treatment.

In a study conducted by Al-Moussawi and his colleagues (2016) to determine the effect of stimulation treatments on the germination of two wheat varieties, it was found that soaking treatments for 6 hours in a 10% potassium nitrate solution had a clear significant effect on most of the studied traits. Al-Moussawi and his colleagues (2018) showed that the soaking treatments were superior in an experiment to determine the effect of soaking wheat seeds in a potassium sulphate solution. The treatment (20% potassium sulphate and soaking for 6 hours) gave the highest values in the radicle length trait, wet seedling weight, and dry weight. Kumari and his colleagues (2017) found that immersing yellow corn seeds in gibberellic acid at a concentration of 10mg/L for (12 hours) had superior germination speed, germination percentage, fresh weight, dry weight, feather length and pod length. Jadoua and Al-Silawi (2012) showed that stimulating rice seeds with gibberellic acid at a concentration of 600 mg/L gave a high average germination percentage of 95.3%. Al-Hadi (2019) showed that stimulating white corn seeds with gibberellic acid at a concentration of 600 mg/L gave the highest average germination speed in the first number and the laboratory germination percentage.

In a study conducted by Al-Moussawi and his colleagues (2016) to stimulate wheat seeds using different concentrations of potassium chloride, it was found that stimulating seeds by soaking them in a

potassium chloride solution had a significant effect on the speed and percentage of laboratory germination, the average length of the plumule and the radical, and the seed vigour. AL-Baldawi and Hamza (2017) showed that stimulating white corn seeds (seeds soaked in distilled water and seeds soaked in potassium chloride at a concentration of 30 mg/L) increased the field germination rate (speed of seedling emergence). Al-Silawi (2011) found that stimulating rice seeds with potassium chloride (20 mg/L), gave a significant increase in the speed of laboratory germination and field emergence.
Al-Rawi (2017) showed in a study to activate sunflower seeds using potassium chloride that the seeds of the Aqmar variety were significantly superior in the laboratory germination rate, the length of the plumule, radical, and the seed vigour index at a concentration of 20g/L. The seeds of the Aqmar variety soaked in a concentration of 20g/L of potassium chloride solution achieved the highest values of interference for the traits of germination speed 81.50%; the seed vigour index 3083; fresh weight of the plumule 1.830g; and dry weight of the plumule 0.083g. In a study conducted by Saudi (2017) on the effect of activation treatments under salt stress on the vitality and the seed vigour of soybean, the results of this study showed the superiority of soybean seeds soaked in a potassium chloride solution (20g/L) by recording the highest averages for the traits of germination speed, germination percentage, length of plumule and the radical, seed dry weight, and the seed vigour index.

Material and methods

This study was conducted in the Seed Testing Laboratory of the Department of Crop Sciences, Faculty of Agriculture, University of Tripoli, during the agricultural season 2022-2023, to study the effect of soaking in potassium chloride solution on the germination stage and seedling growth in bread wheat varieties (Bohouth 208, Bohouth 212 and Abu Al-Khair) sourced from the Agricultural Research Center "Misurata".

Preparation of solutions

In this study, different concentrations of potassium chloride solution were used, where the salts were weighed and their volume was adjusted to a liter with distilled water and the concentrations were (distilled water - 10 - 20 - 30 - 40 g/L of potassium chloride). The seeds were sterilized with sodium hypochlorite (NaHOCaL) at a concentration (10%) for 10 minutes to get rid of fungal or insect infections or pollutants on the surface of the seeds. Then, the seeds were washed with distilled water three times to remove the effect of the sterilizing substance. The seeds were dried on blotting paper and then soaked in plastic containers for 24 hours at room temperature in different concentrations of potassium chloride solution prepared previously and dissolved in distilled water. After the end of the soaking period, the seeds were dried to their original moisture by placing them between two blotting papers. Then, laboratory tests were performed on them. The hands and laboratory tools, including plates, tweezers, and the work area (the experimental area) were sterilized. Then, the seeds were planted at room temperature with 10 seeds in three replicates in previously sterilized glass dishes. The experiment was conducted using, a Completely Randomized Design (CRD) with three replicates of each treatment. Therefore, the number of treatments became 5 × 3 × 3 = 45 treatments; the first number of seeds was carried out 3 days after planting to calculate the germination speed, which was calculated according to the following treatment:

$$\text{Germination speed (seed/day)} = \frac{\text{Number of seeds germinated in the first count}}{\text{Number of days from planting to the first count}} + \frac{\text{Number of seeds germinated in the second count}}{\text{Number of days from planting to the second count}} + - - \frac{\text{Number of seeds germinated in the last count}}{\text{Number of days from planting to the last count}}$$

After 10 days, the germination percentage was calculated according to the following equation:

$$\text{Germination percentage (\%)} = \frac{\text{Number of natural seedlings}}{\text{Number of total seeds}} \text{ X } 100$$

(Saied,1984)

The length of the plumule and the radicle were measured (cm), the fresh weight of the seeds (g) was estimated and the seed vigour was calculated according to the following equation:
The seed vigour = germination percentage (%) × seedling length (plumule length + radicle length)
(Murti *et., al.* 2004).

After collecting and classifying the data, it was statistically analyzed using the statistical program GenStat19. An analysis of variance (ANOVA) was conducted to evaluate the differences, and the least significant difference (LSD) was used at a significance level of 5%.

Results and discussion

Fresh weight (g)

The results showed that there were highly significant differences between the varieties in fresh weight (P<0.001), where the variety, Bohouth 208, was superior to the two varieties (Abu Al-Khair, Bohouth 212), and the variety Abu Al-Khair was significantly superior to the variety, Bohouth 212 (Figure 1). The results also showed that the concentration (20g of potassium chloride/L) was superior to the other concentrations (Figure 2). As for the interaction between wheat varieties and potassium chloride concentrations, the results showed that the Abu Al-Khair variety was significantly superior, followed by the Bohouth 208 variety, at a potassium chloride concentration of 20g/L (Figure 3).

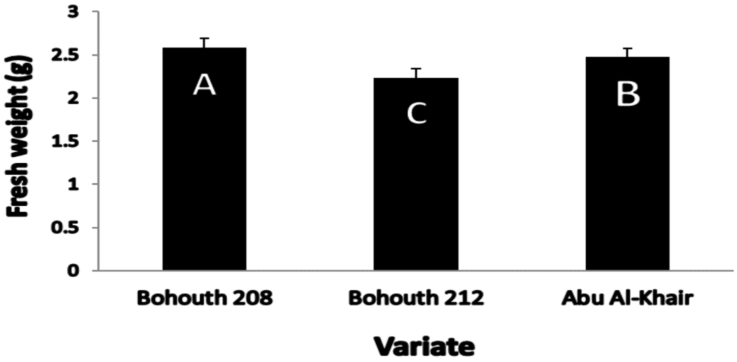

Figure 1. Effect of varieties on fresh weight (g)

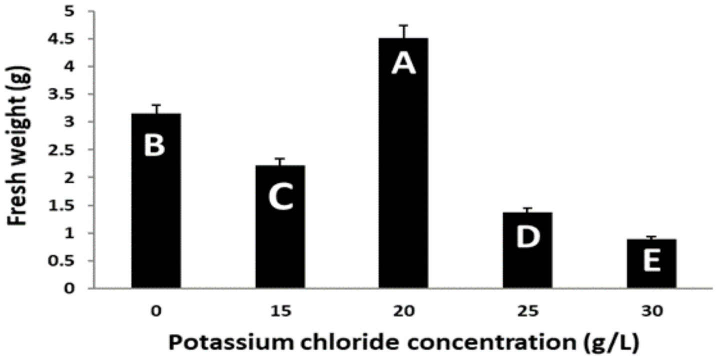

Figure 2. Effect of potassium chloride concentration (g/L) on fresh weight (g)

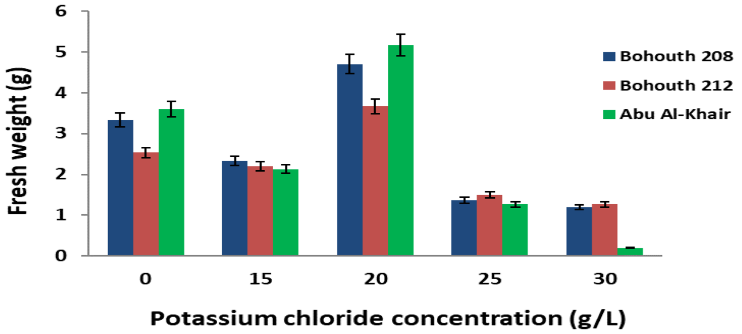

Figure 3. Effect of interaction between varieties and potassium chloride concentration (g/L) on fresh weight (g) (LSD=0.2216)

The seed vigour

The results showed that there were highly significant differences between the varieties in the seed vigour (P<0.001), where the Bohouth 212 variety was superior to the two varieties (Bohouth 208, Abu Al-Khair), and the Bohouth 208 variety was significantly superior to the Abu Al-Khair variety (Figure 4). The results also showed that the concentration (20g of potassium chloride/L) was superior to the other concentrations in terms of the seed vigour (Figure 5). As for the interaction between wheat varieties and potassium chloride concentrations, the results showed that the Bohouth 212 variety, followed by the Bohouth 208 variety, was significantly superior to the Abu Al-Khair variety at a potassium chloride concentration of 20g/L over the rest of the treatments (Figure 6).

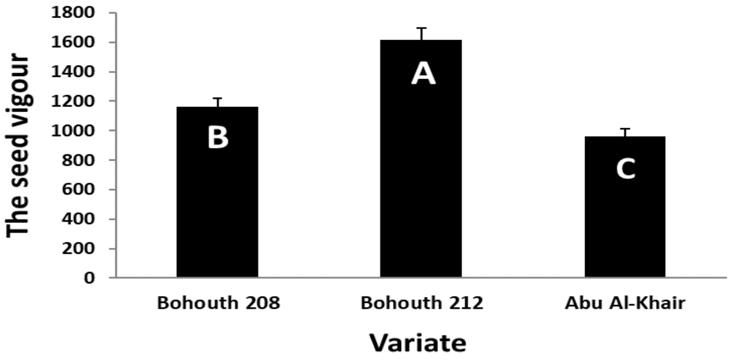

Figure 4. Effect of varieties on the seed vigour

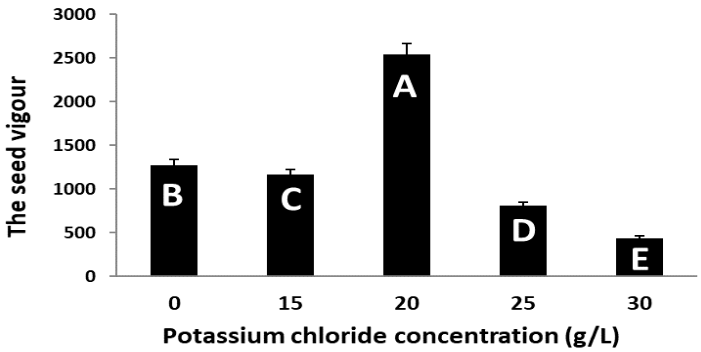

Figure 5. Effect of potassium chloride concentration (g/L) on the seed vigour

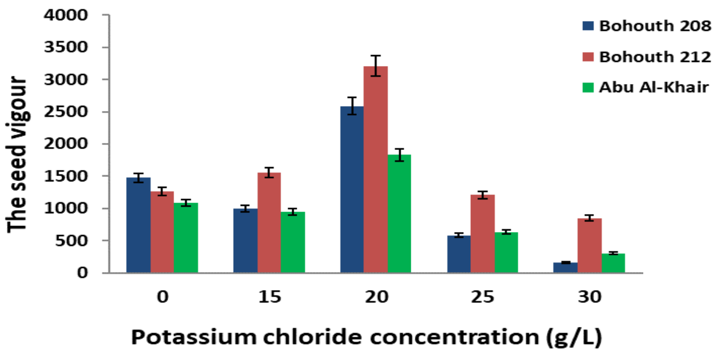

Figure 6. Effect of interaction between varieties and potassium chloride concentration (g/L) on the seed vigour (LSD= 181.1)

Germination speed (seed/day)

The results showed that there were highly significant differences between the varieties in the speed of germination ($P<0.001$), where the variety, Bohouth 212, was superior to the two varieties (Abu Al-Khair, Bohouth 208), and the variety Abu Al-Khair was superior to the variety, Bohouth 208, significantly (Figure 7). The results also showed that the concentration (20g of potassium chloride/L) was superior to the other concentrations in terms of germination speed (Figure 8). As for the interaction between wheat varieties and potassium chloride concentrations, the results showed that the Bohouth 212 variety was significantly superior to the two varieties Abu Al-Khair and Bohouth 208 at a potassium chloride concentration of 20g/L over the rest of the treatments (Figure 9).

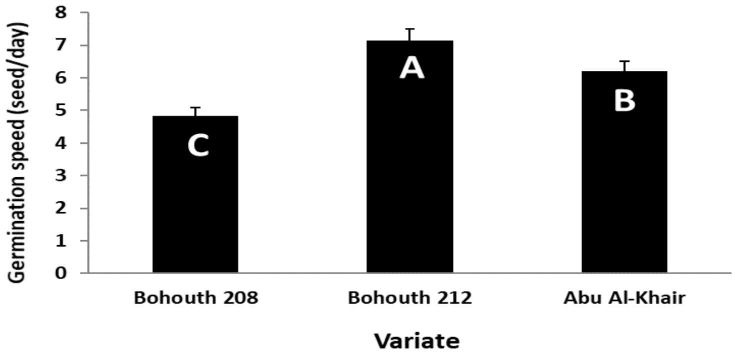

Figure 7. Effect of varieties on the germination speed (seed/day)

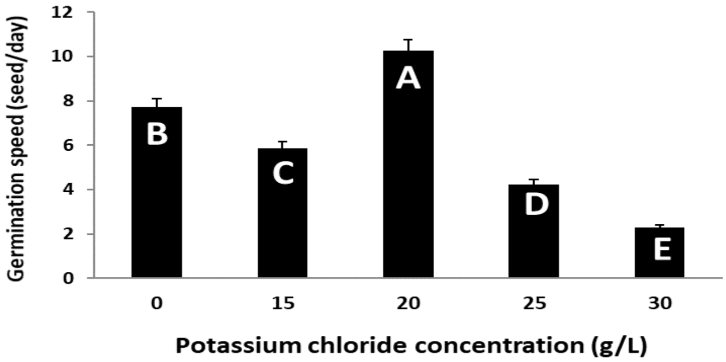

Figure 8. Effect of potassium chloride concentration (g/L) on the germination speed (seed/day)

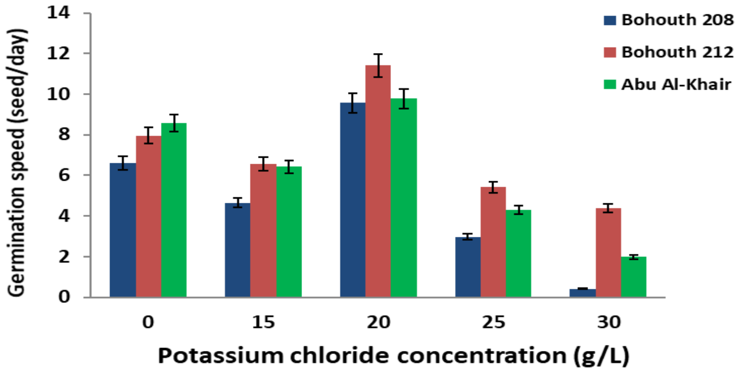

Figure 9. Effect of interaction between varieties and potassium chloride concentration (g/L) on the germination speed (seed/day) (LSD= 1.277)

Germination (%)

The results showed that there were highly significant differences between the varieties in the germination rate ($P<0.001$), where the variety, Bohouth 212, outperformed the two varieties (Abu Al-Khair, Bohouth 212), and the variety Abu Al-Khair outperformed the variety, Bohouth 208, significantly (Figure 10). The results also showed that the concentration (20g of potassium chloride/L) was superior to the other concentrations in terms of germination rate (Figure 11). The results did not show significant differences in interaction between wheat varieties and potassium chloride concentrations.

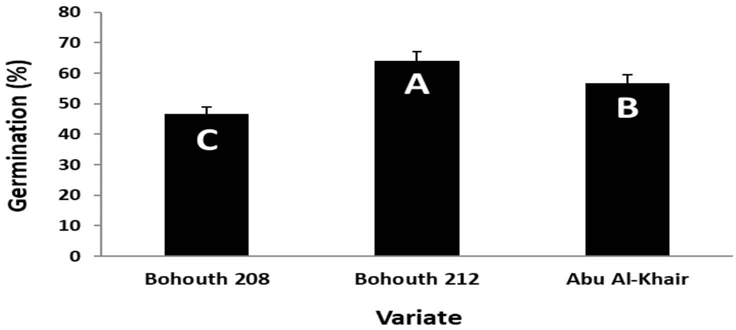

Figure 10. Effect of varieties on the germination (%)

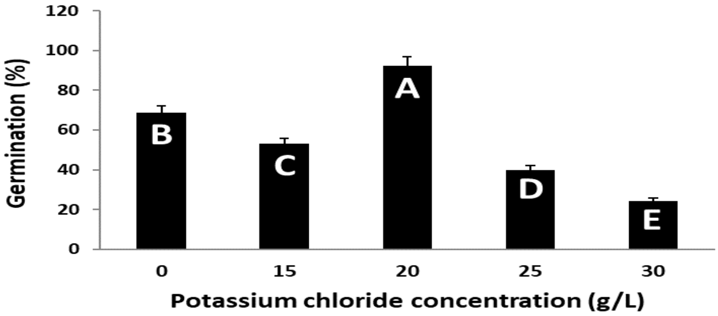

Figure 11. Effect of potassium chloride concentration (g/L) on the germination (%)

The length of the Seedling

The results showed that there were highly significant differences between the varieties in the seedling length ($P<0.001$), where the Bohouth 212 variety was superior to the two varieties (Bohouth 208, Abu Al-Khair), and the Bohouth 208 variety was significantly superior to the Abu Al-Khair variety (Figure 12). The results also showed that the concentration (20g of potassium chloride/L) was superior to the other concentrations in terms of the seedling length (Figure 13). As for the interaction between wheat varieties and potassium chloride concentrations, the results showed that the Bohouth 212 variety, followed by the Bohouth 208 variety, was significantly superior to the Abu Al-Khair variety at a potassium chloride concentration of 20g/L over the rest of the treatments (Figure 14).

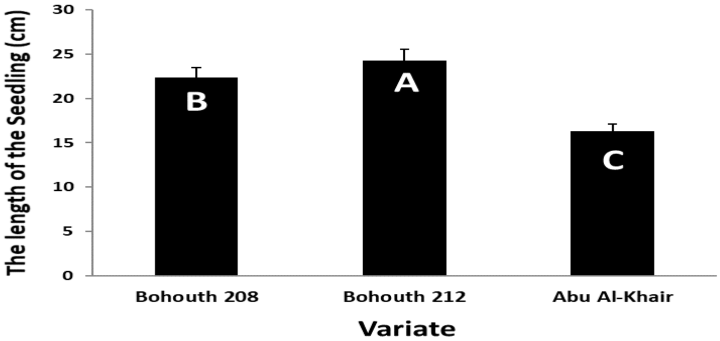

Figure 12. Effect of varieties on the seedling length (cm)

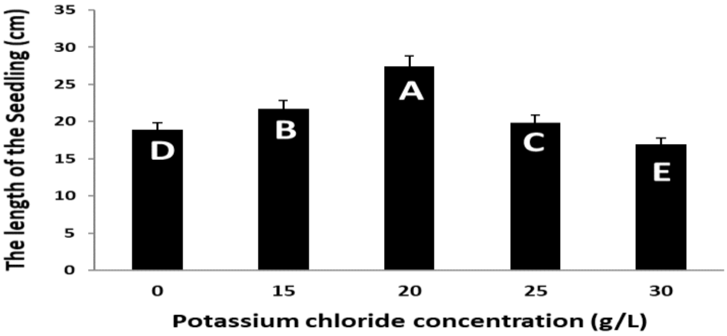

Figure 13. Effect of potassium chloride concentration (g/L) on the seedling length (cm)

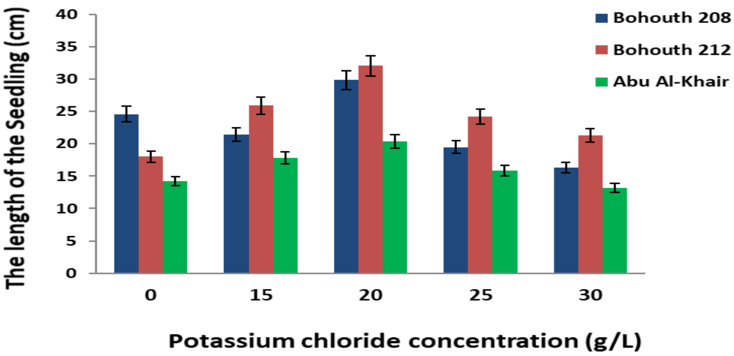

Figure 14. Effect of interaction between varieties and potassium chloride concentration (g/L) on the seedling length (cm) (LSD= 0.4689)

The length of the plumule

The results showed that there were highly significant differences between the varieties in plumule length (P<0.001), where the Bohouth 208 variety was superior to the two varieties (Bohouth 212, Abu Al-Khair), and the Bohouth 212 variety was significantly superior to the Abu Al-Khair variety (Figure 15). The results also showed that the concentration (20g of potassium chloride/L) was superior to the other concentrations in the length of the plumule (Figure 16). As for the interaction between wheat varieties and potassium chloride concentrations, the results showed that the Bohouth 208 variety was significantly superior to the two varieties (Bohouth 212, Abu Al-Khair), then the Bohouth 212 variety was significantly superior to the Abu Al-Khair variety at the potassium chloride concentration of 20g/L over the rest of the treatments (Figure 17).

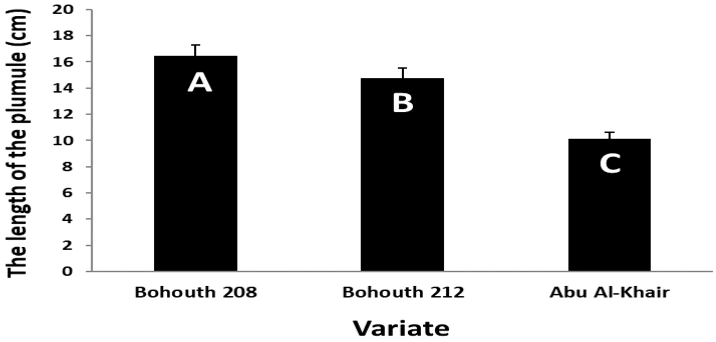

Figure 15. Effect of varieties on the plumule length (cm)

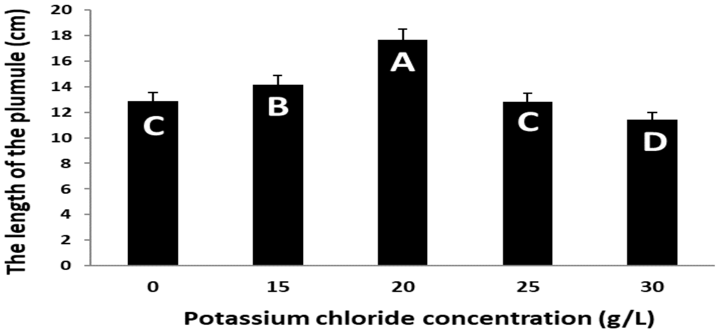

Figure 16. Effect of potassium chloride concentration (g/L) on the plumule length (cm)

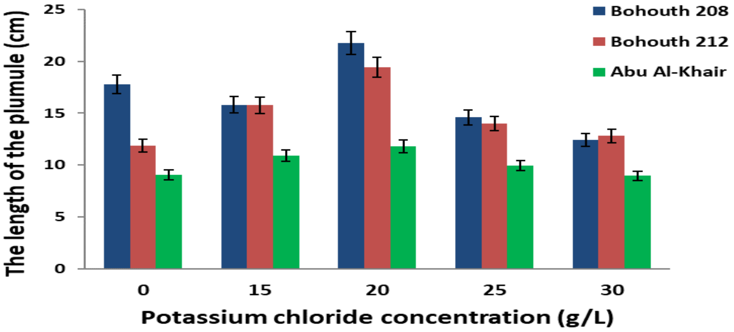

Figure 17. Effect of interaction between varieties and potassium chloride concentration (g/L) on the plumule length (cm) (LSD= 0.4132)

The length of the radicle (cm)

The results showed that there were highly significant differences between the varieties in the radicle length (P<0.001), where the variety, Bohouth 212, was superior to the two varieties (Abu Al-Khair, Bohouth 208), and the variety Abu Al-Khair was superior to the variety, Bohouth 208, significantly (Figure 18). The results also showed that the concentration (20g of potassium chloride/L) was superior to the other concentrations in the radicle length (Figure 19). As for the interaction between wheat varieties and potassium chloride concentrations, the results showed that the Bohouth 212 variety was significantly superior to the two varieties Abu Al-Khair and Bohouth 208 at a potassium chloride concentration of 20g/L over the rest of the treatments (Figure 20).

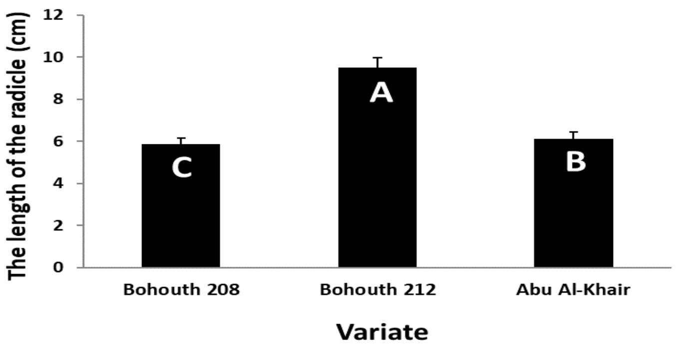

Figure 18. Effect of varieties on the radicle length (cm)

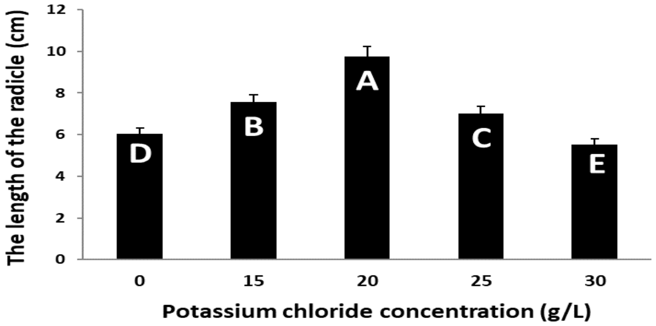

Figure 19. Effect of potassium chloride concentration (g/L) on the radicle length (cm)

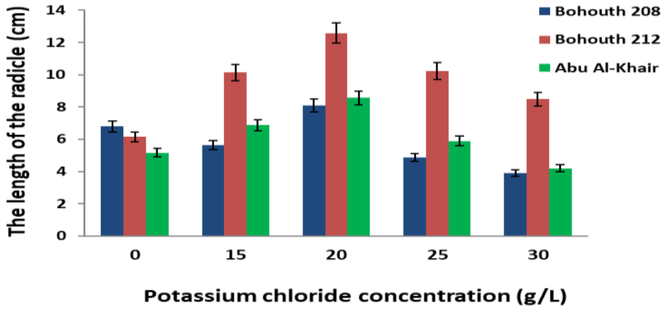

Figure 20. Effect of interaction between varieties and potassium chloride concentration (g/L) on the radicle length (cm) (LSD= 0.3732)

Conclusions:

- The Bohouth 212 variety excelled for most of the characteristics studied in this study, followed by the Bohouth 208 variety.
- The best concentration of potassium chloride to treat seeds and give the best results for all the studied traits is 20g/L, followed by a concentration of 15g/L.

Recommendations:

- This study recommends applying this concentration (20g of potassium chloride/L) to the Bohouth 212 variations in the field and studying this effect on the yield.

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