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THE ROLE OF POTASSIUM SALTS IN REDUCING THE HARMFUL EFFECTS ON THE GROWTH PARAMETERS OF BRINE-STRESSED WHEAT PLANTS

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ABSTRACT : This study was carried out in the Department of Biology, College of Education for Pure Science for winter season 2019-2020 to demonstrate the role of soaking seeds with potassium salts in increasing the tolerance of fine wheat variety Aba 99 to salt stress. The study included soaking with chloride and potassium hydrogen phosphate in addition to the soaking treatment with water and the comparison treatment (without soaking), before planting and irrigation with three salt concentrations of table salt 0.5, 1.0 and 1.5 g.L^{-1} in the growth characteristics of soft wheat plants of class Aba 99. The characteristics of Chlorophyll content, flag leaf area, plant height, number of stems and proline content were studied. The results of the study showed that the seed soaking treatments were significantly different in most of the traits except for plant height and the number of spurs, which were not significantly affected. The increase in the salinity level of the irrigation water led to a significant decrease in the studied traits. The treatments of soaking with potassium hydrogen phosphate and irrigation with plain water were superior for most of the traits by reducing the negative effect of salt stress on wheat plants more than soaking with potassium chloride, and these traits are chlorophyll content, flag leaf area, plant height and number of tillers.

Key words : Potassium salts, growth parameters, wheat, salt stress, proline soaking.

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INTRODUCTION

The wheat crop, *Triticum aestivum* L. is considered to be one of the important strategic grain crops that are widely cultivated in Iraq and depended on reducing the food gap, which has become a problem for the world (Al-Zwaini, 2017). The importance of this crop is due to the fact that it has a high nutritional content for humans, which is used in the production of the best types of bread and pastries (Al-Tamimi, 2020). It is one of the main sources of energy needed by the human body, as it achieves a good balance between proteins and carbohydrates in its grains, so it is called the king of grain crops (Costa *et al*, 2013). There are great challenges that the world is facing today as a result of the demand and the urgent need for this crop as a result of the continuous population growth, as the world population is expected to exceed 9 billion during the year 2050, therefore, the demand for this crop will increase by 50 percent (United Nations, 2015). The wheat crop in Iraq faced many problems that led to a significant deterioration in its quality and a reduction in its yield per unit area compared to global production. Most of the problems faced by this crop are related to the variety, crop service operations and many problems related to drought, soil, lack of water and salinity, and this makes the crop unable to fully exploit its physiological and genetic (Ministry of Agriculture, 2017). Salt concentrations affect plant growth by reducing the water potential of the soil solution, which leads to a reduction in the amount of water absorbed and causes physiological drought. In order for the plant to face this problem, it works to maintain a low osmotic effort to prevent the movement of water from the roots to the soil (Feng *et al*, 2002). It is known that salt stress reduces the plant's ability to absorb water, and this in turn causes a decrease in the growth rate in conjunction with a group of metabolic changes that are similar to those caused by water stress. Munns (2002) mentioned that the initial decline in plant growth as a result of water stress is due to hormonal signals coming from the roots, and then the effect of specialized salts will come when they enter the plant. Salinity also affects the process of building proteins and carbohydrates, transpiration, respiration, photosynthesis and transport across membranes (Hamada and El-Enany, 1994). Salt stress also reduces the effectiveness and activity of cells and their ability to divide, which leads to a decrease in the production of agricultural crops (El-Feki, 2010). Potassium is considered to be one of the important nutrients that the plant needs in large quantities in order to maintain its vital activities to a degree that is no less important than the nitrogen element. It is available in the rest of the nutrients that are added to the plant, such as phosphorous, iron, magnesium, calcium and other elements. It is one of the elements that must be provided to the plant in order to perform the photosynthesis process with a high degree of efficiency, as it thus stimulates the plant to transfer and store the manufactured materials in the leaves to the places where they are stored in the fruits. The positive potassium functions of the plant are not limited to this amount, but extend to other functions, including stimulating the growth of roots in the plant, improving the plant's tolerance to drought and thirst, increasing its ability to withstand harsh winter conditions of extreme cold and freezing, and increasing the efficiency of the plant to absorb nitrogen, highlighting its importance In various metabolic activities (Al-Hujairi, 2013). Potassium also plays an important role in mitigating the harmful effects of high salt concentration in the soil (Gupta and Garg, 1998). The stress tolerance of crops can be enhanced by improving potassium nutrition (Kirkby and Römheld, 2010) and potassium is known for its role in osmosis regulation and stress relief, especially in saline conditions under saline soil conditions (Cakmak, 2010). The quality of irrigation water is one of the important and influential factors in the productivity of field crops in arid and semi-arid areas, including Iraq, which suffers from a severe shortage of water resources as a result of fluctuations in rainfall, which necessitates the search for water of poor quality for use in the agricultural fields in order to activate the role of fresh water and benefit from it in other areas. Irrigation water in Iraq, including fresh water, is considered to contain a percentage of salt, and the process of adding it to the soil leads the cultivated crops to consume a very small amount of it and begin to accumulate over time, and it becomes difficult for the roots of plants to absorb water, which requires reducing its negative effects in the growth of Plant (Ali and Kahlown, 2001). The technique of seed treatment or the so-called Seed Priming before planting is considered as a low-cost and low-risk procedure. Some may think that it may be one of the options that can be followed in order to mitigate the effect of salinity in agricultural lands (Iqbal, 2004). Any process of seed treatment before planting, whether it is soaking with normal water, salt water, some hormones or others for a certain period of time and then drying and planting it, can be considered a process of preliminary preparation for seeds. And the process of salt-hardening of seeds (osmo-priming) or (salt-hardening), that is, soaking the seeds in a saline solution of one of the mineral salts or a mixture of mineral salts is one of the important procedures that have been focused on by research and experiments to study their positive effects on seed germination and the growth of plant seedlings in Many stressful conditions such as salinity and alkalinity and their implications for production and productivity in these conditions (Necker and Pill, 2001). The decrease in chlorophyll content in plants under the influence of salt stress is one of the most common phenomena, and there are many studies that used chlorophyll content as an indicator of plant sensitivity to salinity (Maxwell and Johnson, 2000). Kaydan *et al* (2007) indicated that chlorophyll content decreased when wheat plant was grown under saline stress conditions. TurKyilmaz (2012) noted a decrease in the chlorophyll content of wheat leaves subjected to salt stress and explained the reason for this inhibition in the process of building chlorophyll, and the effect of salt stress appears on the plant as it works to break down protein, chlorophyll reduction and inhibition of the electronic transport process as a result of the formation of chlorophyll enzyme or as a result of changes in Chloroplast structure (Tuna *et al*, 2008). International Potash Institute (IPI) (2000) highlighted the importance of potassium and its role in improving the products of photosynthesis and the speed of transporting these products to storage sites, such as fruit, grains and tubers, as it speeds up the process of converting these products into starch, oils and proteins, which is consistent with what was explained by Member (2004). Al-Sumaida'i (2012) showed that salt stress directly affected the growth and development of plants through its effect on various physiological processes, which are negatively reflected on their leaf area. Brisson and Casals (2005) have indicated a decrease in the area of the flag leaf for different varieties of wheat in order to reduce the water loss available to them under the influence of salt stress. Zayed *et al* (2011) also obtained an increase in the leaf area of rice plants treated by soaking with distilled water under saline stress conditions after 30 days of cultivation. Salt stress causes harmful effects on the growth of crop plants resulting from water and osmotic stress, where salinity reduces the growth of wheat plants through its negative impact on the ability of the plant to absorb water from the soil, and on metabolic activities (Fatma, 2013). Abeer Al-Hallaq (2003) noticed a decrease in the height of wheat plants at two levels of salinity and explained this to the general decrease in plant growth resulting from the negative impact of salt stress on various physiological processes. This decrease also comes as a result of the plant's consumption of energy ATP when taking the necessary nutrients from the growth medium that was affected by salinity, because this energy would have been spent mainly on the vital processes of the plant (Cuin *et al*, 2011; Nada *et al*, 2021). Ruan (2007) noted that the salinity-tolerant cultivars of wheat produced more branches in order to increase their tolerance to salt stress, while the salinity-sensitive cultivars had fewer branches, and this is considered better in plant growth, because the process of forming a larger number of branches has increased the plant's ability to withstand salt stress, because these branches accumulated more sodium and chlorine ions than the original branches. Shamsi and Kobraee (2013) showed that the average number of spurs per plant was significantly reduced when three wheat genotypes were exposed to three levels of irrigation with salt water. Proline plays a key role in protecting the plant from stress, as it acts as an osmotic regulator that protects the plant from stress by maintaining the stability of membranes and enzymes and as an antioxidant (Ashraf and Foolad, 2007 and Farooq *et al*, 2008). The content of proline increases with the age of the plant and the increase in salinity rates (Al-Saeedi, 2005). Many researchers have shown an increase in the accumulation of osmotic organizations such as amino acids, including proline in the tissue when exposed to salt stress, but this increase affects the mechanism of productivity (Turan *et al*, 2007 and Al Ghurairi, 2011). The results obtained by Aldesuquy *et al* (2012), when they studied two cultivars of wheat gemmieza-9 and Sids-1, which were irrigated with salt water, showed that the content of proline in the flag leaf increased by increasing the salinity of the irrigation water. They also noticed a difference in the concentration of proline in different cultivars. Results obtained by Shamis and Kobraee (2013) through their study of three cultivars of wheat, an increase in the proline concentration of wheat cultivars with an increase in brine levels (6,8,16) $dsi.m^{-1}$. Farooq *et al* (2008a) did not notice any significant differences in the mean height of wheat plants when their seeds were stimulated with solutions of potassium chloride, calcium chloride and ascorbic acid. Salehzade *et al* (2009) showed the superiority of soaking treatment with KH2Po4 solution at a concentration of 0.3 with the highest average plant height, which reached 20 cm for wheat, compared to other treatments included in the study. Hadi (2013) carried out her experiment in pots to study the effect of different irrigation periods, which are 5, 10 and 15 days, and the seeds were soaked with water, IAA and H_2O_2 on the growth characteristics of two wheat cultivars. Soaking the seeds with water gave the highest number of tillers amounting to 18.16 and the lowest number of 8.71 tillers for the IAA treatment and 10.94 tillers for H_2O_2 treatment. Noroozi and Sepanlou (2013) indicated that treating some field crops with potassium led to a decrease in the proline content with an increase in potassium concentration. Also, Zhang *et al* (2014) showed that the treatment of yellow corn with potassium led to a significant increase in the content of proline and the rest of other components.

MATERIALS AND METHODS

This study was conducted in the Department of Biology, College of Education for Pure Science/University of Diyala for winter season 2020-2021 to recognize the role of soaking the seeds of wheat variety Aba 99 with potassium salts to reduce the effects of salt stress on growth characteristics. The experiment was carried out in pots as a factorial experiment according to the Randomized Complete Block Design (RCBD) and with four replications, and plastic pots perforated from the bottom with a capacity of 15 kg were used as experimental units. 15 seeds per pot, at a depth of 3 cm, on 9/12/2020. Then the pots were watered with normal water and harvested on 18/4/2020 manually upon reaching maturity. The obtained data were statistically analyzed according to the method of analysis of variance for the split slash system using the ready-made statistical program (SPSS), the fourteenth edition, and the least significant difference L.S.D test was chosen to compare the significant differences between the means at the probability level of 0.05 (Al-Rawi, 1984).

RESULTS AND DISCUSSION

The results presented in Table 1 show the highly significant differences between the averages of soaking treatments on the chlorophyll content in the leaves of wheat plants. The treatment of soaking with potassium hydrogen phosphate recorded the highest chlorophyll content, which amounted to 40.19 $mg.g^{-1}$ and did not differ significantly from the treatment of non-soaking, which amounted to 39.00 mg. The lowest content of chlorophyll was recorded when the soaking was treated with potassium chloride, which amounted to 36.81 mg.g. The reason for the increase is due to the fact that potassium is one of the essential nutrients for plants and plays an important role in various metabolic processes. It also plays a key role in the process of transferring water, carbohydrates and the rest of nutrients in plant tissues. Therefore, the availability of this element in the plant will

Table 1 : Effect of soaking wheat grains with potassium salts before planting and irrigation with different salt concentrations on the chlorophyll content of leaves (%).

NaCl (g/L)	Soaking with				Mean
	control	water	KCl	$KHPO_4$	
0.0	42.00	42.25	42.75	44.25	42.81
0.5	39.00	42.00	39.50	40.50	39.75
1.0	40.00	33.00	31.00	39.00	35.75
1.5	35.00	35.00	34.00	37.00	35.25
Mean	39.00	37.56	36.81	40.19	38.39
L.S.D.	Soaking=1.746	Interaction= 3.493		Irrigation=1.746	

Table 2 : Effect of soaking fine wheat grains with potassium salts and irrigation with different salt concentrations on the area of the flag leaf (cm^2).

NaCl (g/L)	Soaking with				Mean
	Control	Water	KCl	$KHPO_4$	
0.0	42.812	40.422	32.342	48.122	40.925
0.5	43.100	39.610	42.865	37.170	40.686
1.0	41.780	38.027	32.302	44.365	39.118
1.5	39.872	36.807	36.330	33.490	36.375
Mean	41.891	38.716	35.710	40.786	39.276
L.S.D.	Soaking=1.471	Irrigation= 1.471		Interaction=2.944	

increase the content of important chemical compounds for the plant, including chlorophyll (Aziz and Khan, 2013). The results of Table 1 also show highly significant differences between the averages of irrigation water, as salinity negatively affected the chlorophyll content of wheat plants and reached the highest chlorophyll content when irrigated with normal water, which amounted to 42.81 $mg.g^{-1}$ and the lowest content of chlorophyll when irrigated with salt water at concentrations of 1.5 and 1.0 $g.L^{-1}$, which amounted to 35.25 and 35.75 $mg.g^{-1}$, respectively. The reason for this is that high salinity concentrations have a negative effect on the photosynthesis process, through their effect on the fine structure of chloroplasts. As the membranes of these organelles shrink with distortion of the membrane plates carrying chlorophyll pigments, their concentration decreases in high concentrations of salinity and this is due to the lack of absorption of the elements necessary to build the chlorophyll molecule (Al-Wahaibi, 2009). As for the results of the interaction in Table (1), they were significant between grain soaking treatments and irrigation water concentrations for this trait, as the highest chlorophyll content of grains soaked with potassium hydrogen phosphate and irrigated with plain water reached a concentration of 0.0 $g.L^{-1}$, which amounted to 44.25 $mg.g^{-1}$ and less The content of this characteristic for grains soaked in potassium chloride and irrigated with salt water concentration of 1.0 $g.L^{-1}$, which amounted to 31.00 $mg.g^{-1}$.

The results mentioned in Table 2 indicate that there are highly significant differences between the treatments of soaking grains for the average area of the flag leaf of wheat plants, as the non-soaking treatment excelled by giving it the highest mean of leaf area, which amounted to 41,891 cm^2, which did not differ significantly from the treatment of soaking with potassium hydrogen phosphate, as it gave 40.786 cm^2 for the average area of the flag leaf, while the treatment of soaking with potassium chloride recorded the lowest average of 35,710 cm^2. The reason is due to the negative effect of salinity on the leaf area due to the accumulation of sodium, and the reason for the decrease in the leaf area owing to the effect of increased salinity may be due to the inhibition of the photosynthesis process, which may be due to the osmotic effect resulting from the low amount of water entering the plant, as well as the lack of transfer of nutrients and hormones growth from the roots to the rest of the plant parts due to the low amount of water absorbed (Tuteja, 2001). Or, because of the decrease in the osmotic pressure of the leaf cells, which leads to a decrease in their elongation and consequently a decrease in the leaf area (Mengel *et al*, 2002). As for the irrigation with saline water, it caused highly significant differences between the irrigation water treatments on the averages of this trait, as the highest mean of the area of the flag leaf for its plants irrigated with water with a concentration of 0.0 $g.l^{-1}$when amounted to 40.925 cm^2, which did not differ significantly from their plans irrigated with saline water at concentration of 0.5 $g.L^{-1}$, while the lowest average area of the flag leaf for plants irrigated with saline water was at a concentration of 1.5 $g.L^{-1}$, as it reached 36.375 cm^2. This is due to the salt stress, which increases the average of transpiration of the leaves, causing the accumulation of salt in the leaves, which leads to a decrease in the area (Bahrani and Haghjoo, 2012). Regarding the results of the interaction shown in Table 2, they had highly significant differences with respect to the average area of the flag leaf for wheat plants, as the

Table 3 : The effect of soaking wheat grains with potassium salts before planting and irrigation with different salt concentrations on plant height (cm).

NaCl (g/L)	Soaking with				Mean
	Control	Water	KCl	$KHPO_4$	
0.0	60.23	63.10	64.52	67.30	63.79
0.5	63.31	62.41	58.36	60.06	61.03
1.0	60.08	53.72	54.91	50.38	54.77
1.5	50.10	52.51	52.45	47.84	50.72
Mean	58.43	57.93	57.56	56.40	57.58
L.S.D.	Soaking= N.S.	Irrigation=2.099	Interaction= 4.199		

Table 4 : Effect of soaking fine grains of wheat with potassium salts before planting and irrigating with different salt concentrations on the number of tillers in the plant.

NaCl (g/L)	Soaking with				Mean
	Control	Water	KCl	$KHPO_4$	
0.0	19.75	18.50	14.25	19.75	18.05
0.5	16.75	14.75	16.75	16.25	16.13
1.0	14.75	16.50	17.75	13.50	15.63
1.5	15.50	16.50	14.75	12.75	14.88
Mean	16.69	16.56	15.88	15.56	16.17
L.S.D.	Soaking=N.S.	Irrigation=1.052	Interaction=2.104		

highest mean for this trait was for plants soaked in grains with potassium hydrogen phosphate and irrigated with water with a concentration of 0.0 g.l, which amounted to 48.122 cm^2. This is due to the effect of K_2HPO_4 (Hanan, 2016) and the lowest average for this trait was for plants soaked in potassium chloride and irrigated with salt water with a concentration of 1.5 g.L^{-1}, which amounted to 32.302 cm^2, and it did not differ significantly from the treatment of soaking grains with potassium chloride and irrigating with salt water whose concentration was 1.0 g.L^{-1}.

The results shown in Table 3 did not show any statistically significant differences between the treatments of soaking the grains, but it is clear from the same table that there are significant differences between the irrigation water treatments for the average height of wheat plants, as the highest average of the height of plants when irrigated with regular water reached 63.79 cm and the lowest average height of the plant when irrigated with salt water of 1.5 g.L^{-1} concentration, which amounted to 50.72 cm. This is attributable to the salt stress increases the negative osmotic potential of the soil solution, which leads to a decrease in water absorption by the plant and thus inhibiting the growth of cells and their elongation and expansion (Abboud, 1998). With respect to the results of the interaction between the concentrations of irrigation water and the grain soaking treatments in Table 3, they were significant with respect to the average plant height, as the highest average height of wheat plants whose grains soaked with potassium hydrogen phosphate and irrigated with normal water at a concentration of 0.0 g.L^{-1}, which reached 67.30 cm. The lowest average plant height for grains soaked with the same treatment, but irrigated with salt water at a concentration of 1.5 g.L^{-1}, which amounted to 47.84 cm.

Table 4 indicates that irrigation with different saline concentrations caused a significant decrease in the average number of tillers per plant, which amounted to 14.88 tiller.plant^{-1} at concentration 1.5 g.L^{-1} compared to the comparison treatment of 18.05 tiller.plant^{-1}. The decrease in the number of tiller.plant-1 at the concentration of 1.5 g.L^{-1} is attributed to the fact that the high salt stress led to a reduction in the products of photosynthesis, which reduced the amount of nutrients available during the period of emergence of the tillers from the main stem, and thus the competition for them became great, which led to a decrease in the number of tillers in the plant (Langer, 1979). As for the results of the interaction shown in Table 4, they were significant with respect to the average number of tillers, as the highest average number of tillers was for wheat plants soaked with potassium phosphate and irrigated with water at a concentration of 0.0, which amounted to 19.75 tiller..plant^{-1}, whereas, he average number of tillers was lower for grains soaked with the same treatment, but irrigated with salt water, with a concentration of 1.5 g.L^{-1}, which amounts to 12.75 tiller.plant^{-1}.

The results displayed in Table 5 show that there are significant differences between the treatments of soaking the grains in the proline content of wheat plants, as the lowest proline content in the non-soaking treatment was 2.445 µg.g^{-1}, and the highest proline content when treating the grains with potassium chloride was 3.437 µg.g^{-1}, which did not differ significantly from the treatment of soaking with potassium hydrogen phosphate, as the content of

Table 5 : Effect of soaking fine grains of wheat with potassium salts before planting and irrigation with different salt concentrations on the proline content of leaves (µg.g^{-1}).

NaCl (g/L)	Soaking with				Mean
	Control	Water	KCl	KHPO$_4$	
0.0	1.510	1.620	2.310	2.020	1.865
0.5	2.130	2.410	3.020	2.840	2.600
1.0	2.940	3.130	3.910	3.720	3.425
1.5	3.200	3.700	4.510	3.740	3.787
Mean	2.445	2.715	3.437	3.080	2.919
L.S.D.	Soaking=0.180	Irrigation=0.180		Interaction=N.S.	

proline was 3.080 µg.g^{-1}. The increase is due to the fact that potassium plays a role in building protein, which leads to the accumulation of proline and an increase in carbohydrate production when the plant is exposed to external stress (Tisdale *et al*, 2005). The results in Table 5 also show the significant differences between the mean of the irrigation water treatments in the proline content of wheat plants, as the highest content of this trait was recorded for the plants irrigated with salt water, with a concentration of 1.5 g.L^{-1}, which amounted to 3.787 µg, which did not significantly differ from its plants irrigated with saline water at a concentration of 1.0 g.L^{-1}, as the content was 3.425 µg.l^{-1} and the lowest content of this characteristic for plants irrigated with water with a concentration of 0 g.L^{-1}, reached 1.865 µg.g^{-1} and this may be due to the fact that proline acts as an osmoregulater and its accumulation will be due to the lack of conversion of amino acids into proteins, as well as the processes of protein catabolism, of which proline is an essential component, or perhaps it was the cause of the transformation of some amino acids such as glutamic acid to proline and the accumulation of proline is an indicator of sensitivity or tolerance of the plant (Moussa, 2006).

CONCLUSION

The salinity of irrigation water led to a significant decrease in the growth parameters of wheat plant. Soaking with potassium hydrogen phosphate was the best in improving the growth indicators of the plant. Soaking the seeds with potassium chloride did not play an important role in the studied traits.

Recommendations

Conducting a field study for the same research factors in order to compare the results of the two studies (field and pots) and use higher concentrations of potassium salts in order to know the optimal concentration in increasing the tolerance of wheat to the conditions of salt stress.

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