Eco. Env. & Cons. 27 (August Suppl. Issue) : 2021; pp. (S51-S56)
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ISSN 0971–765X

Effect of seeds soaking in GA_3 for studying the Ionic balance of Yellow Sorghum under Salt Stress

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(Received 27 March, 2021; Accepted 1 May, 2021)

ABSTRACT

The study was conducted in the fall season of 2020 to know the effect of soaking yellow corn seeds with different concentrations of gibberellin on the ionic balance of yellow corn under salt stress. The study showed that the use of different types of salt water led to a significant increase in the amount of potassium, calcium, sodium and chloride absorbed in the plant tissue and that the seeds were soaked with gibberellin at concentrations of 300, 600 and 900 $mg_{GA3}L^{-1}$, It led to a significant increase in the absorption of potassium and calcium ions, compared to a significant decrease in the absorption of sodium and chloride. Also, expressing the percentage of ions to each other is better than expressing their absolute quantity, as increasing the percentage of potassium or calcium to sodium. It increases the permeability of cell membranes, improves the osmotic pressure, builds protein, photosynthesis, controls stomata work, and thus increases plant resistance to endure salt stress.

Key words: *Gibberellin, Soaking, Ionic Balance, Salt stress, Yellow sorghum.*

Introduction

Salinity is one of the most important environmental problems that affect the production of crops in arid and semi-arid regions, especially irrigated lands worldwide (Zowain, 2014; Mahmood *et al.*, 2020), Soil salinity is the most devastating among them which not only limits plant growth andmetabolism but also poses a foremost intimidation tosustainable agricultural production throughout the world particularly in arid and semi- arid areas**,** More than 400 million hectares of the totalgeographical area of the world are affected by highconcentration of the soluble salts (AL-Taey, 2009; Al-Khafajy, 2020).

Yellow corn is one of the crops sensitive to salinity in the early stages, especially when irrigation with saline water, but it can tolerate salt stress in later stages of development (Cieck *et al.*, 2002). One of the direct effects of salt stress is the ionic imbalance in the plant. Abood and Abbas (2013) indicated that the use of some growth regulators and the spraying of nutrients on plants exposed to salt stress or drought can help in adjusting the ionic balance within the plant. and that the expression of the concentration of ions inside the plant is in the form of elements percentage to each other and is better compared to the concentration of the ions alone. such as K: Na or Ca: Na, and cultivation with saline soils or the use of saline irrigation water types may contain elements of sodium and chloride at concentrations that It is absorbed by the plant and thus works to raise the osmotic pressure of the plant cells to tolerate the high osmotic pressure in the soil as a result of increased salinity, or that these elements (sodium and chloride) accumulate inside the plant tissues and reach the toxicity limit, thus affecting plant growth and production. Facing the direct effects of salt stress on the plant, many methods have been used to mitigate this harmful effect, including the use of growth regulators whether spraying on the plant or soaking the seeds before cultivation.

phytohormones are considered the important components for changing physiological processes, it's a critical requirement for plants, Phytohormones act either at their site of synthesis or elsewhere in plant cells (Hamza and AL-Taey,2020)

Gibberellins (GAs) are a large group of tetracyclic diterpenoid carboxylic acids, The GAs show positive effects on seed germination, leaf expansion, stemelongation, flower and trichome initiation, and flower and fruit development. They are essential for plants throughout their life cycle for growth-stimulatory functions. They also promote developmental phasetransitions. Interestingly, there is increasing evidence for their vital roles in abiotic stress response and adaptation (AL-Taey, 2017) ,where gibberellin (GA_3) has a stimulating effect on plant growth under conditions of salt stress, As it leads to rapid elongation in the stems of plants and treatment of dormancy in seeds and buds, and the reason is due to the effect of gibberellin on the speed of decomposition of the iron layer so that the radical rushes rapidly through the seed coat (Baslah, 1998), (Abbas, 2013) also indicated that spraying wheat under salt stress with gibberellin at a concentration of 200 $mg.l^{-1}$ led to an increase in the absorption of potassium and calcium ions and a decrease in the sodium concentration, thus raising the K: Na and Ca: Na ratios in favor of potassium and calcium. Therefore, the present study aims to evaluate the effectiveness of soaking yellow corn seeds with gibberellin in the ionic balance of yellow corn plants under conditions of salt stress.

Materials and Methods

Agriculture

The experiment was conducted in one of the agricultural fields of Babylon province during the autumn season of 2020, using the Randomized Complete Block Design (RCBD), with the arrangement of the split-plot, with three replications. As the main plot included three levels of irrigation water types: (Q_1 river water Ec = 1.5 dSm^{-1}), (Q_2 drainage water Ec = 4.3dSm^{-1}) and (Q_3 drainage water Ec = 8.5dSm^{-1}), The secondary plot included a 12 hour soaking treatment of yellow corn seeds with gibberellin with four levels: (T_0 Control without GA_3), (T_1=300 $mg_{GA3}l^{-1}$), (T_2=600 $mg_{GA3}l^{-1}$) and (T_3=900 $mg_{GA3}l^{-1}$). The operations of preparing the soil for cultivation were conducted from Tillage, smoothing, leveling, and divided into experimental units (3*4*3=36experimental units) with dimensions of 2 * 2 m^2. Each experimental unit included three lines, and between one line and another 50 cm, and between one and another 30 cm, and between each experimental unit and another 75 cm, and the distance between one and the other was 75 cm. Use IPA cultivar and add before cultivation urea fertilizer at an average of 400 $Kgha^{-1}$ and triple superphosphate fertilizer at an average of 200$Kgha^{-1}$, Hand weeding was conducted and the Corn stem Borer was controlled using diazinon pesticide (10% active ingredient) (6 $Kg.ha^{-1}$) after 20 days of cultivation and for three times with an interval of 10 days.

Soil analysis

Soil samples were taken at a depth of 0-40 cm from the field soil, passed through a 2 mm sieve after it was dried and saturated paste extract was made, and the analyzes shown in Table 1 were performed according to the methods described in (Salim and Ali, 2017).

Table 1. Physical and Chemical Characteristics of the Soil under Study

Character		Value	Unit
Soil Texture	Sand	263	gm Kg^{-1}
	Silt	579	
	Clay	158	
Class of Texture		Si L	———-
Bulk Density		1.23	Mg m^{-3}
Field Capacity		35	%
Wilting Point		14	%
CEC		23.17	$Cmol_+ Kg^{-1}$
O.M.		0.7	gm Kg^{-1}
$CaCO_3$		275	gm Kg^{-1}
pH_e		7.48	———-
EC_e		4.23	dSm^{-1}
Concentrations of Cations and Anions in Saturated Paste Extract ($_e$)			
Na^+		13.36	mmol Kg^{-1}
K^+		0.94	
Ca^{+2}		6.88	
Mg^{+2}		5.37	
Cl^-		14.47	
HCO_3^-		5.61	
$CO_3^=$		Nil	
$SO_4^=$		**5.78**	

Analysis of irrigation water qualities

The water qualities used in agriculture were analyzed and classified (Table 2), according to the methods described in (Salim and Ali, 2017).

Table 2. Chemical Characteristics of Water Quality

Character	Q_1	Q_2	Q_3	Unit
pH	7.28	7.31	7.22	———-
EC	1.4	4.3	8.5	dSm^{-1}
Ca^{+2}	6.2	8.1	10.6	mmol L^{-1}
Mg^{+2}	4.3	6.2	8.4	
Na^{+}	10.5	14.6	17.9	
K^{+}	0.6	0.8	1.1	
Cl^{-}	11.4	18.6	21.8	
HCO_3^{-}	3.8	5.1	5.7	
$CO_3^{=}$	Nil	Nil	Nil	
$SO_4^{=}$	3.2	3.9	5.8	
Sodium Adsorption Ratio (SAR)	3.3	3.8	4.1	(mmol $L^{-1})^{1/2}$
Class of Water	C_2S_1	C_2S_2	C_2S_2	———-

Plant analysis

Plant samples were taken in the form of leaves, which were dried and grind it, and for the purpose of converting the dry matter content of the plant from nutrients into a solution for estimation, the wet digestion method is used for that and according to the method described in (Salim and Ali, 2017), After extraction, the sodium and potassium elements were determined with a Flame photometer, and calcium by titrated with EDTA and chloride by titrated with AgNO3, was described in (Salim and Ali, 2017).

Results and Discussion

The results in Table 3 indicate that the addition of salinity levels of irrigation water led to a significant increase in the amount of potassium absorbed, as it reached 26.76 and 32.28 g kg^{-1} for Q_2 and Q_3 levels, respectively, compared to the Q_1 level, which reached 17.78 g kg^{-1}. The results in Table 3 also showed that soaking the seeds with gibberellin led to a significant increase in potassium absorption, as it reached 24.96, 27.58 and 28.57 g kg^{-1} for T_1, T_2 and T_3 levels, respectively, compared to the T_0 level, which reached 21.32g kg^{-1}. Also, the interaction between the study factors showed that the treatment Q_3T_2 gave the highest average of the amount of potassium absorbed, which was 34.02 g kg^{-1} compared to treatment Q_1T_0, the lowest average for the amount of potassium absorbed was 13.56 g kg^{-1}. The results in Table 3 indicate that the addition of salinity levels of irrigation water led to a significant increase in the amount of calcium absorbed, as it reached 36.91 and 41.89 g kg^{-1} for Q_2 and Q_3 levels, respectively, compared to the Q_1 level, which reached 31.77 g kg^{-1}. The results in Table 3 also show that soaking the seeds with gibberellin led to a significant increase in the absorption of calcium, as it reached 27.00, 40.57 and 38.73 gm kg^{-1} for T_1, T_2 and T_3 levels, respectively, compared to the T_0 level, which reached 31.11 g kg^{-1}. Also, the interaction between the study factors showed that the treatment Q_3T_2 gave the highest average of the amount of calcium absorbed, which reached 44.29 g kg^{-1}, compared to treatment Q_1T_0, the lowest average of the amount of potassium absorbed was 23.13 g kg^{-1}. The results in Table 3 indicate that the addition of salinity levels of irrigation water led to a significant increase in the amount of sodium absorbed, as it reached 9.58 and 15.08 g kg^{-1} for the levels Q_2 and Q_3, respectively, compared to the level Q_1, which reached 3.46 g kg^{-1}. The results in Table 3 also showed that soaking the seeds with gibberellin led to a significant decrease in sodium absorption, as it reached 10.60, 8.31 and 6.21 g kg^{-1} for the levels T_1, T_2 and T_3, respectively, compared to the T_0 level, which reached 12.38 g kg^{-1}. Also, the interaction between the study factors showed that the treatment Q_3T_0 gave the highest average of the amount of sodium absorbed, which reached 19.46 g kg^{-1} compared to treatment Q_1T_3, the lowest rate of the amount of sodium absorbed was 1.99 g kg^{-1}.The results in Table 3 indicate that the addition of levels of salinity of irrigation water led to a significant increase in the amount of absorbed chloride, as it reached 11.83 and 17.49 g kg^{-1} for the levels Q_2 and Q_3 respectively compared to the level Q_1, which reached 5.25 g kg^{-1}. The results in Table 3 also show that soaking the seeds with gibberellin led to a significant decrease in the absorption of chloride, as it reached 12.54, 10.37 and 8.65 g kg^{-1} for T_1, T_2 and T_3 levels, respectively, compared to the T_0 level, which reached 14.55 g kg^{-1}. Also, the interaction between the study factors showed that the treatment Q_3T_0 gave the highest average for the amount of absorbed chloride which reached 22.25 g kg^{-1} compared to the treatment Q_1T_3, the lowest average for the amount of absorbed chloride was 3.59 g kg^{-1}. They note from the results in the Table 3 there is a significant increase in the absorption of potassium, calcium, sodium and chloride elements, with an increase in the salinity levels of the water qualities, and this is due to the increase in the concentration of these ions in the soil solution when irrigation with these qualities (Table 2), which led to an increase in their absorption by the plant (Al-Qahtani, 2004; Abbas, 2013; Abood and Abbas, 2013). Also, the soaking of yellow corn seeds with concentrations of gibberellin led to a significant increase in the amount of potassium and calcium absorbed compared to a significant decrease in the absorption of sodium and chloride. This is due to the direct effect of gibberellin in increasing the permeability of cell membranes and thus contributes to activating the H^+ proton pumping or the effect on the bearing mechanism and thus works to equalize the osmotic pressure in the plant growth environment and this is reflected in the plant's absorption of water and nutrients, thus increasing the plant's resistance to various environmental stresses, including salt stress. (Abbas, 2013).

The results in Table 4 indicate that the addition of levels of salinity of irrigation water led to a significant decrease in the percentage of potassium to sodium (K:Na), as it reached 3.03 and 2.35 for levels Q_2 and Q_3, respectively, compared to the level Q_1, which reached 6.25. The results in Table 4 also show that soaking the seeds with gibberellin led to a significant increase in the ratio of potassium to sodium (K:Na), reaching 3.10, 4.08 and 6.36 for T_1, T_2 and T_3 levels, respectively, compared to the T_0 level, which reached 1.97. Also, the interaction between the study factors showed that the treatment Q_1T_3 gave the highest rate of the ratio of potassium to sodium (K:Na) which was 11.16 compared to treatment Q_3T_0. The results in Table 4 indicate that the addition of levels of salinity of irrigation water led to a significant decrease in the ratio of calcium to sodium (Ca:Na), as it reached 4.16 and 3.02 for Q_2 and Q_3 levels, respectively, compared to the Q_1 level, which reached 10.79. The results in Table 4 also show that soaking the seeds with gibberellin led to a significant increase in the ratio of calcium to sodium (Ca:Na), reaching 5.03, 6.73 and 9.17 for T_1, T_2 and T_3 levels, respectively, compared to the T_0 level, which reached 3.04. Also, the interaction between the study factors showed that the treatment Q_1T_3 gave the

Table 3. The Effect of Gibberellin on the Amount of Absorbed Ions (gm Kg^{-1})

Treatment	Concentration K^+ Ion in Plant			
	Q_1	Q_2	Q_3	Avg. T
T_0	13.56	21.40	29.01	21.32
T_1	16.00	26.73	32.14	24.96
T_2	19.70	29.03	34.02	27.58
T_3	21.86	29.88	33.97	28.57
Avg. Q	17.78	26.76	32.28	
L.S.$D_{0.05}$	Q=0.98		T=1.13Q*T=1.95	
Treatment	**Concentration Ca^{+2} Ion in Plant**			
	Q_1	Q_2	Q_3	Avg. T
T_0	23.13	30.97	39.24	31.11
T_1	31.99	37.36	41.66	37.00
T_2	38.14	39.29	44.29	40.57
T_3	33.82	40.01	42.38	38.73
Avg. Q	31.77	36.91	41.89	
L.S.$D_{0.05}$	Q=1.33		T=1.54 Q*T=2.66	
Treatment	**Concentration Na^+ Ion in Plant**			
	Q_1	Q_2	Q_3	Avg. T
T_0	4.99	12.68	19.46	12.38
T_1	3.66	10.08	18.07	10.60
T_2	3.22	8.79	12.93	8.31
T_3	1.99	6.78	9.86	6.21
Avg. Q	3.46	9.58	15.08	
L.S.$D_{0.05}$	Q=0.66		T=0.76Q*T=1.31	
Treatment	**Concentration Cl^- Ion in Plant**			
	Q_1	Q_2	Q_3	Avg. T
T_0	7.28	14.11	22.25	14.55
T_1	4.93	13.02	19.66	12.54
T_2	5.18	10.92	15.00	10.37
T_3	3.59	9.28	13.08	8.65
Avg. Q	5.25	11.83	17.49	
L.S.$D_{0.05}$	Q=1.01		T=1.17Q*T=2.02	

Table 4. The Effect of Gibberellin on Ion Ratios

Treatment	K^+:Na in Plant			
	Q_1	Q_2	Q_3	Avg. T
T_0	2.72	1.69	1.49	1.97
T_1	4.84	2.67	1.79	3.10
T_2	6.30	3.31	2.65	4.08
T_3	11.16	4.45	3.46	6.36
Avg. Q	6.25	3.03	2.35	
L.S.$D_{0.05}$	Q=0.66		T=0.77Q*T=1.33	
Treatment	**Ca^{+2}:Na in Plant**			
	Q_1	Q_2	Q_3	Avg. T
T_0	4.66	2.44	2.02	3.04
T_1	9.01	3.75	2.32	5.03
T_2	12.27	4.48	3.44	6.73
T_3	17.22	5.98	4.32	9.17
Avg. Q	10.79	4.16	3.02	
L.S.$D_{0.05}$	Q=1.10		T=1.27Q*T=2.20	

highest average of calcium to sodium (Ca:Na) ratio, which was 17.22 compared to treatment Q_3T_0, the lowest average of calcium to sodium (Ca:Na) ratio was 2.02. They note from the results in the Table 4 there is a significant decrease in the ratio of potassium to sodium (K:Na) and the ratio of calcium to sodium (Ca:Na), and this is due to the increase in the concentration of sodium ions with the increase in salinity of the quality of irrigation water, or due to the competitive effect on the absorption sites in the roots of the plant between potassium, calcium and sodium ions Especially in the case of covalent ions (Hummadi, 1977; Devitt *et al.*, 1981; Abbas, 2013; Abood and Abbas, 2013). Also, the soaking of yellow corn seeds with concentrations of gibberellin led to a significant increase in the potassium to sodium and calcium percentage to the sodium in the vegetable tissue, As Tester and Davenport (2003) mentioned that one of the keys to salt tolerance is the ability of plant cells to maintain an ideal percentage of potassium to sodium, being important in controlling osmosis in cells, their swelling, stomata functions, enzyme activation, protein synthesis and photosynthesis (Shabala *et al.*, 2003). Ebert *et al.* (2002) indicated that the cationic relationships in leaf tissue as in the case of calcium to sodium have a strong controlling effect on salt tolerance more than the absolute value of sodium.

Conclusion

From the results of this study that the use of different types of salinity water leads to a negative impact on the growth of various agricultural crops, whether medium or high tolerance, and thus on the production of these crops as a result of the imbalance that salinity makes through the imbalance of nutritional balance within the plant tissue, the use of gibberellin, whether it was spraying on the plant or soaking the seeds of plants, led to the mitigation of the harmful effect of salinity on the plant, and the expression of the ratios of beneficial ions for the plant to the harmful ones inside the plant is better than the expression of the amount of ion absorbed inside the plant, since these beneficial ions increase plant resistance for salt stress.

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