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Effect of Salicylic Acid and Gibberellin Acid on Germination and Growth of Wheat under Different Levels of Salinity

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Abstract: The laboratory experiment was conducted on bread wheat (*Triticum aestivum*) cv. Abu-Ghraib in laboratory. Two factors were used; the first was concentrations of salicylic acid (SA) at 25, 50 and 75 mg/l, the second was gibberellin acid(GA) at 250, 500, and 750 mg/l. dry seeds, and seeds soaked in water, watering was done by distilled water 3.13, 7.81, and 12.50 ds/m. The soaking of seed for 24h in 75 mg/L SA solution gave higher speed of germination, germination, length of radicle and coleoptile, seedling dry weight, seedling vigor and seeding vigor index. The increased salinity had decreased all studied traits. However the solution of 12.5 ds/m gave no germination.

***Keywords*:** *Triticum aestivum* L., Gibberellin acid, Salicylic acid Seed germination, Seedling vigor

Salinity of water and soil in the world is an expanding problem, this could be a result of climate change or greenhouse effect. In Iraq, water flow in Euphrates and Tigre as are getting lesser than before. Besides this there is limited rainfall in most middle and south governorates of Iraq and management of resources water for irrigation is very poor (Ghazal and Esmaeel 2017). High percent of germination and uniformity give better field performance, but salinity of water and / or soil has its negative effect on productivity. The use of new technologies in plant breeding, tissue culture, and molecular biology could contribute some solutions but these are limited in Iraq (Hamid and Abood 2014). Meanwhile, desalinization of saline soils can play important role but progress is low. The seed priming, as a simple technique could enhance germination to give better stand and performance of wheat (Afzal 2005). The use of plant growth regulators has been used in Iraq, such as using auxins, gibberellin, and cytokines to limit the salt stress (Farahbakhah and Saiid 2011). Wheat is considered somewhat tolerant to salt stress. This present study was conducted with soaking seeds in solutions of some plant hormones and evaluate for salt tolerance.

MATERIAL AND METHODS

The experiment was carried out in the laboratory of the College of Agriculture, University of Diyala, Iraq. The wheat cultivar used was Abu-Ghraib. The objectives of this experiment were to determine the effect of seed priming by using SA and GA under saline water of 0, 3.13, 7.81, and 12.50 ds/m irrigation water, salt used was sodium chloride dissolved in distilled water. Two checks were used, dry seeds and seeds soaked for 24h in distilled water. Three concentrations were used of each SA and GA (Table 1).

The experiment was in complete randomize design with four replications. Seeds were treated with sodium hypo chloride (1%) for three minutes then washed with distilled water, and left to dry off for 48h. Seeds then soaked with solutions for 12h of SA and GA solutions as mentioned in Table 1. Data were recorded on 50 seeds of each experimental unit, and the germination was tested in petri dishes of 15cm diameters with blotter paper with fifty seed in each replication. Each dish received 30ml of saline water, 0, 3.13, 7.81, and 12.50 ds/m. Dishes inoculated in incubator on 25Cº ± 2Cº and 95% humidity (ISTA 2008). The first count was done 5 days after five day later, the second count was done by dividing total normal seedling by total seeds. Ten normal seedlings were randomly taken, then length of radicle and coleoptile measured. Seedling were put in perforated paper envelops and dried for 24 h at 80 C°, after cooling were weighed and weight of seedling was determined. Seedling vigor was determined (Murti et al 2004):

Seedling vigour = Final germination (%) × (radicle length + coleoptile length).

Seedling vigour index was determined according to Farahan and Maroufi (2011):

Seedling vigour index = Final germination (%) × seedling dry weight.

RESULTS AND DISCUSSION

Germination speed: The significant differences were observed due to seed priming under salt stress and r interaction in different treatments. Seeds soaked in 75 mg/L SA solution and 500 mg/L GA caused higher seed germination speed (0.73%) as compared to dry seeds as check(0.65%). This may be due to SA effect in cellular metabolism responsible for enzyme activity of water hydrolysis through germination, in which some compounds in the endosperm were hydrolyzed into simpler forms. GA activated alpha-amylase in the endospores aleurone of grain. This enzyme is known to convert starch into sugars which in turn raise the osmosis of cells (Attiya and Jaddoa 1999). Salt stress treatments have reduced germination speed (Table 2). Seeds treated with distilled water (control) performed better (0.84%) than the rest and speed germination decreased to 0.47 percent in NaCl solution of 7.31 ds/m. More sodium chloride reduces imbibition of seeds which in turn reduced germination speed. Khodarahmpour et al (2012) confirmed that high osmosis reduces water absorption by seeds that causes ionic toxicity and delay germination. Interaction of seeds soaked in 500 mg/L GA and grown in distilled water gave better germination speed (0.93%) followed by 25 mg/L SA grown in distilled water. This germination speed was reduced in treatments of saline solutions which reached its minimum in 750 mg/L GA grown in saline solution of 7.81 ds/m. This indicates that this concentration of NaCl is considered high for this cultivar seeds and could be due to hormonal imbalance in the seed.

Table 1. Concentrations of different treatments and experimental details

Treatment	Symbols	Concentrations (mg/L)
Salicylic acid	AS1	25
	AS2	50
	AS3	75
Gibberellin	GA3 1	250
	GA3 2	500
	GA3 3	750
Check 1	Distilled water	Distilled water
Check 2	Dry seed	Dry seed

Germination (%): The significant differences in germination due to seed priming under salt stress and interaction in different treatments was observed. Seeds soaked in 75 mg/L SA solution caused higher germination (0.81%) compared with other treatments. This could be attributed to SA effect in raising enzyme activity. SA is also depressing ABA activity which in turn moves metabolites to the endosperm. SA also reduced physic-chemical activates in the seed throng germination and builds proteins. Salt stress treatments have reduced germination percentage (Table 3). Seeds the control (distilled water) gave better germination (0.89%) compared with Seeds grown in saline water of 7.81 ds/m which gave lower value (0.55%). However, the solution of 12.5 ds/m gave no germination. Ghuoulam and Fares (2001) reported that the saline water negatively affect embryo activity which leads to low germination. Interaction of seeds soaked in 75 mg/L SA and grown in distilled water gave better germination (0.97%) followed by 500 mg/L GA grown in distilled water (0.93%).

Radicle length (cm): The significant differences due to seed priming under salt stress and their interaction in different treatments were observed. Seeds soaked in 75 mg/L SA solution caused higher radicle length (4.2 cm) with non-significant difference with seed soaked in 50 mg/L SA and 500 mg/L of GA_3. The positive effect of salicylic acid in radicle length may be due to SA compatibility with amino acids, besides due to antioxidant property. SA is one of the phenolic compounds of multi activities, in addition to SA is also depress ABA activity which in turn moves metabolites to the endosperm and reduced physic-chemical activates in the seed through germination and builds proteins. GA_3 is also involved in cell division and elongation (Tsakalidi and Barouchas 2011). Salt stress treatments have reduced radicle length (Table 4). Seeds in control (distilled water) gave

Table 2. Effect of seed priming by using SA and GA_3 under saline water on germination speed

Saline water	Seed priming								Means
	Dry seed	Distil water	GA_3 (mg L^{-1})			SA (mg L^{-1})			
			250	500	750	25	50	75	
0	0.80	0.73	0.82	0.93	0.87	0.85	0.85	0.90	0.84
3.13	0.72	0.72	0.77	0.82	0.75	0.75	0.75	0.77	0.75
7.81	0.43	0.55	0.48	0.43	0.40	0.43	0.50	0.52	0.47
12.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSD 5%				0.10					0.03
Means	0.65	0.67	0.69	0.73	0.67	0.68	0.70	0.73	
LSD 5%				0.06					

radicle length (4.4 cm) compared with seeds grown in saline water of 7.81 ds/m (2.4 cm). These results are in agreement with Afzal el al (2005). Interaction of seeds soaked in 500 mg/L of GA_3 which grown in distilled water gave higher radicle length (5.6 cm) followed by 25 mg/L SA which grown in distilled water (5.5 cm).

Coleoptile length (cm): The significant differences due to seed priming under salt stress and their interaction in different treatments. Seeds soaked in 75 mg/L SA solution caused higher coleoptile length (5.3 cm) compared with other treatments. The reason of increasing in coleoptile length may be due to its role of salicylic acid in hormonal stimulation and formation of chlorophyll a and b as well as carotenoids in leaves and then increasing coleoptile elongation (Kaydan et al 2006). Salt stress treatments have reduced coleoptile length (Table 5). Seeds the control (distilled water) gave better value (5.6 cm) compared with Seeds grown in saline water of 7.81 ds/m which gave lower value (2.1 cm). Interaction of seeds soaked in 75 mg/L of SA which grown in distilled water gave higher coleoptile length (8.8 cm) while of 750 mg/L GA grown in 7.81dsm gave lower value (1.3 cm). The Increased of GA_3 could affect osmosis and hormones negatively (Bahrani and Pourrreza 2011).

Seedling dry weight (g): The significant differences due to seed priming under salt stress and their interaction in different treatments. Seeds soaked in 75 mg/L SA solution caused higher seedling dry weight (0.14 g) while dry seeds (check) gave only 0.08 g. This could be due to the positive effect of SA in activating of enzyme systems in the seed and facilitate metabolites transport to seedling and then increasing dry weight. Salt stress treatments have reduced seedling dry weight (Table 6), Seeds in the control (distilled water) gave higher dry seedling weight (0.14 g) compared with seeds grown in saline water of 7.81 ds/m which gave lower value (0.07 g). This is due to negative effect of sodium ions on seedling growth. The results in table 6 show that seedling soaked in 75 mg/L SA growth in distilled water gave heavier seedling dry weight (0.19 g) compared with all salt treatments (Table 6). However, both SA and GA has enhanced wheat seedling to tolerate the toxicity of sodium ions.

Seedling vigour: The significant differences due to seed

Table 3. Effect of seed priming by using SA and GA_3 under saline water on seed germination

Saline water	Seed priming								Means
	Dry seed	Distil water	GA_3 (mg L^{-1})			SA (mg L^{-1})			
			250	500	750	25	50	75	
0	0.88	0.85	0.83	0.93	0.90	0.85	0.88	0.97	0.89
3.13	0.80	0.80	0.83	0.87	0.80	0.78	0.85	0.88	0.83
7.81	0.53	0.60	0.50	0.55	0.53	0.53	0.55	0.57	0.55
12.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSD 5%				0.08					0.03
Means	0.74	0.75	0.72	0.78	0.74	0.72	0.76	0.81	
LSD 5%				0.05					

Table 4. Effect of seed priming by using SA and GA_3 under saline water on radicle length

Saline water	Seed priming								Means
	Dry seed	Distil water	GA_3 (mg L^{-1})			SA (mg L^{-1})			
			250	500	750	25	50	75	
0	4.2	4.3	3.9	5.6	2.9	4.2	4.7	5.5	4.4
3.13	4.0	4.0	3.9	3.8	3.3	3.9	4.1	4.3	3.9
7.81	2.7	1.7	2.3	2.4	1.6	2.7	2.9	2.8	2.4
12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSD 5%				1.0					0.4
Means	3.7	3.4	3.4	3.9	2.6	3.6	3.9	4.2	
LSD 5%				0.6					

priming under salt stress and their interaction in different treatments were recorded on seedling vigour. Seeds soaked in 75 mg/L SA solution caused higher seedling dry weight (8.16 g) compared with other treatments and increase may be due to superiority of seeds soaked in 75 mg/L SA on germination percentage (Table 3), radicle length (Table 4) and coleoptile length (Table 5). Salt stress treatments have reduced seedling vigour (Table 7). The seeds in control (distilled water) gave better vigour (8.97) compared with seeds in saline water of 7.81 ds/m (2.44). The seedling soaked in 75 mg/L SA growth in distilled water had highest seedling vigour (13.85) followed by 500 mg/L GA in distilled

Table 5. Effect of seed priming by using SA and GA_3 under saline water on coleoptile length

Saline water	Seed priming								Means
	Dry seed	Distil water	GA_3 (mg L^{-1})			SA (mg L^{-1})			
			250	500	750	25	50	75	
0	5.2	4.3	4.8	6.2	4.4	5.0	6.1	8.8	5.6
3.13	3.2	3.2	3.8	3.4	2.8	3.9	3.9	4.0	3.5
7.81	2.2	1.5	1.9	2.0	1.3	2.2	2.3	3.1	2.1
12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
LSD 5%				0.9					0.3
Means	3.5	3.0	3.5	3.8	2.8	3.7	4.1	5.3	
LSD 5%				0.5					

Table 6. Effect of seed priming by using SA and GA_3 under saline water on seedling dry weight

Saline water	Seed priming								Means
	Dry seed	Distil water	GA_3 (mg L^{-1})			SA (mg L^{-1})			
			250	500	750	25	50	75	
0	0.110	0.110	0.120	0.140	0.120	0.160	0.160	0.190	0.140
3.13	0.080	0.080	0.100	0.120	0.090	0.100	0.120	0.130	0.100
7.81	0.060	0.060	0.060	0.080	0.070	0.060	0.080	0.080	0.070
12.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD 5%				0.022					0.012
Means	0.080	0.080	0.090	0.110	0.090	0.110	0.120	0.140	
LSD 5%				0.008					

Table 7. Effect of seed priming by using SA and GA_3 under saline water on seedling vigour

Saline water	Seed priming								Means
	Dry seed	Distil water	GA_3 (mg L^{-1})			SA (mg L^{-1})			
			250	500	750	25	50	75	
0	8.31	7.37	7.29	10.99	6.57	7.79	9.59	13.85	8.97
3.13	5.76	5.76	6.45	6.22	4.89	6.14	6.80	7.30	6.17
7.81	2.66	1.96	2.07	2.50	1.52	2.66	2.82	3.32	2.44
12.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSD 5%	1.31								0.45
Means	5.57	5.03	5.27	6.57	4.33	5.53	6.40	8.16	
LSD 5%	0.76								

Table 8. Effect of seed priming by using SA and GA_3 under saline water on seedling vigour index

Saline water	Seed priming								Means
	Dry seed	Distil water	GA_3 (mg L^{-1})			SA (mg L^{-1})			
			250	500	750	25	50	75	
0	0.10	0.10	0.10	0.13	0.11	0.14	0.14	0.19	0.13
3.13	0.06	0.06	0.08	0.10	0.07	0.08	0.10	0.12	0.08
7.81	0.03	0.04	0.03	0.04	0.04	0.03	0.04	0.05	0.04
12.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSD 5%	0.018								0.006
Means	0.06	0.07	0.07	0.09	0.07	0.08	0.09	0.12	
LSD 5%	0.010								

water (10.99), while it decreased with increased water salinity (Table 7). Al-Obaidy (2015) also obtained similar trend

Seedling vigor index: The significant differences due to seed priming under salt stress and their interaction in different treatments were observed on seedling index. Seeds soaked in 75 mg/L SA solution caused higher seedling dry weight (0.12) compared with dry seeds (check) which gave the lowest (0.08). The increase may be due to superiority of seeds soaked in 75 mg/L SA in germination percentage (Table 3) and seedling dry weight (Table 6). These results are in agreement with Kaydan et al (2006) who reported that the SA stimulate hormones to make chlorophyll more active to produce more plastids which lead to an increase the seedling dry weight and the seedling vigor Index. Seedling stress gave different result in seedling vigor index. Increased salinity has decreased seedling vigour index to lower values. Seeds soaked in 75 mg/L SA grown in 7.81ds/m water gave the lower value (0.04). This result was in agreement with Farhana et al (2014). The seeds primed with 75 mg/L SA and grown in distilled water gave higher values, while those primed with any other concentration of both SA and GA and grown in 7.81ds/m gave lower value (Table 8). This shows some positive effect of GA and SA in enhancing wheat seed to tolerate toxicity of sodium chloride. This could be behind the positive effects of both SA and GA in reducing ionic toxicity and improve balance of nutrient metabolism and transport.

CONCLUSION

The wheat seeds are sensitive to salinity stress at germination and seedling growth. The SA and GA concentration in wheat seed priming could useful under salinity stress and further evaluation under field condition recommend for better germination stand, and grain yield of wheat under different salinity of soil and / or water.

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