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Impact of Salinity on Germination Percentage and Seedling Growth in Sorghum (*Sorghum bicolor* L.) var. CSH – 14

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ABSTRACT: In both controlled and natural situations, salinity is one of the major concerns impacting seed germination, plant growth, and photosynthetic efficiency in the majority of species. In order to assess the effects of salinity on the quality of sorghum seeds, the current study was conducted to determine the impact of salinity on germination percentage and seedling growth in Sorghum (*Sorghum bicolor* L.), under controlled conditions. The experiment was carried out in the laboratory of Department of Genetics and Plant Breeding, Sam Higginbottom University of Agricultural Technology and Sciences, Prayagraj, Uttar Pradesh during 2021-2022.

The seeds are treated with KCl, $CaCl_2$, NaCl, $MgCl_2$ salts. The treatments are as follows, T_0- Control, T_1, T_2, T_3 – KCl @ 50, 100, 150 mM, T_4, T_5, T_6 - $CaCl_2$ @ 50, 100, 150 mM, T_7, T_8, T_9 – NaCl @ 50, 100, 150 mM, T_{10}, T_{11}, T_{12} – $MgCl_2$ @ 50, 100, 150 mM respectively. The experiment was laid out in Randomized Block Design with thirteen treatments including control which were replicated four times.

The experiment results revealed that seeds treated with $CaCl_2$ 50mM for 12 hours performed better than other treatments on seed quality in sorghum. That is Germination energy (88%), germination percentage (94.50%), root length (18.72 cm), shoot length (12.22 cm), seedling length (30.95 cm), root – shoot ratio (1.63 cm), root fresh weight (0.76 gm), root dry weight (0.15 gm), shoot fresh weight (0.84 gm), shoot dry weight (0.08 gm), seedling vigour index I (2926.56), seedling vigour index II (23.15) found highest in T_4 treatment than all other treatments.

Keywords: Sorghum, Salinity, Different Salts, Germination, Seedling Growth.

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.)] is the fifth important cereal crop in the world after wheat, rice, maize and barley. Of late, it has emerged as 'fuel' crop in addition to its food, feed and fodder utilities. Sorghum is a major cereal crop, being grown extensively in tropical and subtropical regions of the world. It is an important food crop for a large section of people in Africa and Asia and also the main source of fodder and industrial raw material. Sorghum [*Sorghum bicolor* (L.)] belongs to family Gramineae, origin is Ethiopia. Chromosome no: 2n=20. Sorghum also called as Great Millet or Indian Millet. Sorghum is an annual crop. Inflorescences raceme type (Panicle), Seed (fruit type), grain (caryopsis), Sorghum is ideally suitable for semi-arid agro-climatic regions. It is drought tolerant crop. Sorghum is the principle source of energy, protein, vitamin, minerals, and trace elements for millions of the poorest people. Sorghum grain has certain properties that make it suitable to be consumed by people suffering from chronic disorders. On average, 100 g of the grain has about Calories: 329, Protein: 11 grams, Fat: 3 grams, Carbohydrates: 72 grams, Fiber: 7 grams Sorghum is also a good source of the following micronutrients: vitamin B1 (thiamin), vitamin B6, copper, iron, magnesium, phosphorus, potassium, selenium, zinc (Watson, 2022). For 2020-21, USDA has projected world sorghum area as 40.97 million hectares (101.23 million acres) and production as 59.76 million tonnes. For India, the same was projected as 4.80 million hectares (11.86 lakh acres) and 4.40 million tonnes respectively. India ranks third in jowar area and fifth in production in the world. productivity of 1235 Kg per hectare (500 Kg per acre) (PJTSAU, 2020).

Salt stress reduces the ability of plants to take up water and this quickly causes reduction in growth rate (Rani,

2011) Salinity is known as one of the important a biotic stresses factor that limit plant growth and productivity (Ibrahim *et al*., 2011). There are different salts present in soil and water. The salinity of soil and water effects the plant growth it may enhance the crop growth or retard. The salts available in different forms and they are NaCl, KCl, $MgCl_2$, $CaCl_2$ etc. Salinity inhibits crop growth and development, through complex traits that include osmotic stress, ion toxicity, mineral deficits, and physiological and biochemical defects (Munns and Tester 2008). In addition, under saline conditions, osmotic and ionic stress leads to the production of reactive oxygen species (ROS) in chloroplasts, mitochondria, and the apoplastic space (Khan *et al.,* 2012). This oxidative stress causes membrane peroxidation; ion leakage, and damage to nucleic acids, cell membranes, and cellular structure and ultimately, reduces the quality and total yield of the affected crop (Hessini *et al.*, 2015). Seed coating and seed priming are the main two methods for enhancement of sorghum seed germination under salt stress conditions. Seed priming is one of the most frequently used techniques. This pre-sowing treatment allows partial hydration of seeds without causing full radicle protrusion. Seed priming usually involves the first two stages of seed germination (imbibition and activation), and it eventually leads to a higher seed germination rate and improves the uniformity of germination. Seed priming technology is used to improve germination under both favorable and unfavorable conditions, and its effects may be greater under adverse conditions than under favorable conditions (Xue *et al*., 2014). Although all stages of plant growth are affected by salt stress, the seed germination stage is the most sensitive. Seed germination is inhibited by high concentrations of sodium and chloride ions, mainly because they reduce the osmotic potential of the surrounding environment, thereby suppressing seed imbibition and embryo growth. In addition, ion toxicity also destroys macromolecular substances and affects energy utilization and metabolism during germination. Numerous studies have shown that salt stress can significantly reduce seed vigor and inhibit germination and early seedling growth in many species. Effective methods for promoting seed germination in saline conditions are therefore needed, and they are especially crucial for crop production on saline-alkali land (Chen *et al.*, 2021).

MATERIAL AND METHODS

The lab- test was carried out in the laboratory of department of Genetics and Plant Breeding, Sam Higginbottom University of agricultural, Technology and Sciences, Prayagraj, (Uttar Pradesh) during *Zaid* 2021- 2022. During investigation various seed treatments such as Control, 50 mM KCl, 100 mM KCl, 150 mM KCl, 50 mM $CaCl_2$, 100 $CaCl_2$, 150 mM $CaCl_2$, 50 mM NaCl, 100 mM NaCl,150 mM NaCl, 50 $MgCl_2$, 100 mM $MgCl_2$, 150 $MgCl_2$ in order to evaluate the effect of priming on seed quality parameters such as germination energy, germination percent, shoot length(cm), root length(cm), seedling length(cm), shoot-root ratio, root fresh weight (g), root dry weight (g), shoot fresh weight (g), shoot dry weight (g), seedling vigour index I and seedling vigour index II in sorghum crop.

RESULTS AND DISCUSSION

Germination energy: As per the data depicted in table 3 among the all treatments the mean germination energy of sorghum was found maximum in T_4 - 88% ($CaCl_2$ 50 mM) and minimum in T_{12} - 80.75% ($MgCl_2$ 150 mM) statistically at par T_7 - 85% (NaCl – 50 mM), T_1 – 84% (KCl 50mM). Salinity affects seed germination process through osmotic stress, ion – specific effects and oxidative stress, shown by decreasing germination rate and extended germination time (Munns 2002). The germination energy in sorghum decreased by salinity was reported by Kandil *et al.* (2012).

Germination percent: As per data shown in table 3 among the all treatments the mean germination percent of sorghum was found maximum in T4 – 94.50% ($CaCl_2$ 50 mM) and minimum in T_{12} – 86.25 % ($MgCl_2$ 150 mM) statistically at par T_7 – 92.75% (NaCl – 50 mM), T_1 – 90.25% (KCl 50mM), The seedling emergence and germination percent in sorghum decreased by salinity was reported by Kandil *et al.* (2012). The reduction of the percentages of germination with increasing salinity was due to the specific ion effect (Hassen, 1999), or toxicity of salts (Al- Moaikal, 2006), or due to the effect of added Cl- ions (Gill *et al.,* 2001), to the limited water supply due to low osmotic potential (Chauhan *et al*., 2016).

Root length: As per the data depicted in Table 3 among the all treatments the mean root length of sorghum was found maximum in T_4 - 18.72 cm ($CaCl_2$ 50 mM) and minimum in T_9 – 6.96 (NaCl 150 mM) statistically at par T_0- 17.54 cm (Control), T_{10}– 16.97 cm ($MgCl_2$ 50mM). Focusing specifically on the influences of salts on roots, typical salt-related effects include decreases in root elongation (Potters *et al.* 2007; Bernstein, 2013), changes in root architecture (Julkowska *et al.* 2014), changes in the root gravity response ("halotropism "; Sun *et al.* 2008), and changes in root anatomy, including decreases in cell size, a reduction in cell division, and alterations in patterns of differentiation.

Shoot length: The data pertaining shoot length was depicted in Table 3 among the all treatments the mean shoot length of sorghum was found maximum in T_4 – 12.23 cm ($CaCl_2$ 50 mM) and minimum in T_9 – 6.50 cm (NaCl 150 mM) statistically at par T_0- 11.85 cm (Control), T_{10}– 11.68 cm ($MgCl_2$ 50mM). Reduction in shoot length might be caused by a reduced number of elongated cells and the reduced rate of cell elongation **(**Farooq *et al.,* 2015) and this happen due to lower transport rate of essential ions like NO_3^- & Cl^- due to salinity that reduce the N compounds and increased Na+ in plant under high salinity (Hamid *et al.,* 2008).

Seedling length: As per the mean data from table 3 among the all treatments the mean seedling length of sorghum was found maximum in T_4 – 30.95 cm ($CaCl_2$ 50 mM) and minimum in T_9 – 13.47 cm (NaCl 150mM) followed by T_0- 29.38 cm (Control), T_{10}– 28.65 cm ($MgCl_2$ 50mM). Salinity may lead to disturbances in plant metabolism that leads to reduction of plant height, as reported by Chauhan *et al.* (2016).

Root – shoot ratio: The data pertaining to root – shoot ratio are depicted in table 3 among the all treatments the mean root – shoot ratio of sorghum was found maximum T_4– 1.63 cm ($CaCl_2$ 50mM), in and minimum in T_9 – 1.09cm (NaCl 150 mM) statistically at par T_5– 1.55 cm ($CaCl_2$ 100 mM), T_2 –1.53 cm (KCl 100 mM). With increase in salt stress the mean shoot root ratio significantly decreased in all the treatments. The same results were reported (Spandana *et al.,* 2021).

Root fresh weight: As per data shown in table 3 among the all treatments the mean root fresh weight of sorghum was found maximum in T_4 – 0.76g ($CaCl_2$ 50 mM) and minimum in T_9 – 0.51g (NaCl 150 mM) statistically at par T_0- 0.67g (Control), T_{10}– 0.66g ($MgCl_2$ 50mM). The reduction of seedling fresh weight may be due to a decrease in water uptake by seedling for arising osmotic potential under saline conditions (Aloui *et al.,* 2014).

Root dry weight: As per the data pertained in table 3 among the all treatments the mean root dry weight of sorghum was found maximum in T4 – 0.15g ($CaCl_2$ 50 mM) and minimum in T9 – 0.07g (NaCl 150 mM) statistically at par T0- 0.15%g (Control), T10– 0.14g, ($MgCl_2$ 50mM). The toxic effect of Na^+ at high salt concentration might have caused physical damage to roots, thereby decreasing their ability to absorb water and nutrient, which might have resulted in poor growth. These results agree with those reported by Khan *et al*. (1990).

Shoot fresh weight: As per the data depicted in table 3 among the all treatments the mean shoot fresh weight of sorghum wasfound maximum in T_4 – 0.84g ($CaCl_2$ 50 mM) and minimum in T_9 – 0.42g (NaCl 150 mM) statistically at par T_0- 0.74g (Control), T_{10}– 0.72g ($MgCl_2$ 50mM). This decrease in shoot fresh weight may be due to nutrient stress and toxic effect of Na^+ and hence a decrease in the rate of photosynthesis at higher salinity levels (Carlos and Bingham 1973; Kawasaki *et al.*, 1983).

Shoot dry weight: The data pertaining shoot dry weight was depicted in Table 3 among the all treatments the mean shoot dry weight of sorghum was found maximum in T_4– 0.08g ($CaCl_2$ 50 mM) and minimum in T_9– 0.05g (NaCl 150 mM) statistically at par T_0- 0.07g (Control), T_{10}– 0.06g ($MgCl_2$ 50mM), T1 – 0.06g (KCl 50mM). The negative response of dry biomass with increasing salinity stress may be attributed to decreased rate of photosynthesis. The stem dry weight showed decreased with increasing salinity, compared to control observed by Islam *et al.* (2011).

Seedling vigour index I: As per data shown in table 3 among the all treatments the mean seedling vigour index – I of sorghum was found maximum in T_4 – 2926.56 ($CaCl_2$ 50 mM) and minimum in T_9 – 1191.55 (NaCl 150 mM) statistically at par T_0- 2646.07% (Control), T_{10}– 2513.91 ($MgCl_2$ 50mM). The seedling vigor index increased when the NaCl concentration decreased, which shows that increased salt concentration caused a harmful effect in the seedling. The results of the experiment revealed that various germination and seedling growth parameters of the wheat genotypes varied significantly under salt stress Dehnavi *et al.* (2020).

Seedling vigour index II: As per the data depicted in table 3 among the all treatments the mean seedling vigour index – II of sorghum was found maximum in T_4 – 23.15 ($CaCl_2$ 50 mM) and minimum in T_9 – 11.06 (NaCl 150 mM) statistically at par T_0- 19.80 (Control), T_{10}– 18.64 ($MgCl_2$ 50mM). In addition to the cellular toxicity of NaCl in seedlings and reduction of chlorophyll content under saline condition which may also affects the seedling vigour index II. Similar findings were also reported by Hasan *et al.* (2016) in wheat.

Table 1: Treatments details.

Treatments	Chemicals	Intensity	Duration
T_0	Control	—	—
T_1	KCl	50mM	12 hours
T_2	KCl	100mM	12 hours
T_3	KCl	150mM	12 hours
T_4	$CaCl_2$	50mM	12 hours
T_5	$CaCl_2$	100mM	12 hours
T_6	$CaCl_2$	150mM	12 hours
T_7	NaCl	50mM	12 hours
T_8	NaCl	100mM	12 hours
T_9	NaCl	150mM	12 hours
T_{10}	$MgCl_2$	50mM	12 hours
T_{11}	$MgCl_2$	100mM	12 hours
T_{12}	$MgCl_2$	150mM	12 hours

Table 2: Analysis of variance for different seedling growth parameters in Sorghum under salinity.

Sr. No.	Characters	Mean Sum of Squares	
		Treatments(d.f.=12)	Error (d.f.=39)
1.	Germination energy	12.984*	4.160
2.	Germination percent	20.125*	2.962
3.	Root length	39.069*	0.782
4.	Shoot length	13.965*	0.753
5.	Seedling length	96.273*	1.967
6.	Root -shoot ratio	0.099*	0.014
7.	Fresh weight of root (g)	0.020*	0.002
8.	Dry weight of root (g)	0.003*	0.001
9.	Fresh weight of shoot (g)	0.060*	0.001
10.	Dry weight of shoot (g)	0.002*	0.001
11.	Seedling vigour index-I	854,214.057*	20,583.857
12.	Seedling vigour index-II	43.903*	2.690

* Indicates significance at 5% level of significant

Table 3: Comparison between overall mean of different treatments with different Salinity levels in Sorghum.

Sr. No.	Treatments	Chemicals	Intensity	Germi nation energy	Germination percent	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Root-Shoot ratio	Fresh weight of root (g)	Dry weight ofroot (g)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Seedling vigour index-I	Seedling vigour index-II
1.	T0	Control	—	83.75	90	17.54	11.85	29.38	1.520	0.678	0.15	0.745	0.07	2,646.07	19.8
2.	T1	KCl	50mM	84	90.25	16.72	11.54	28.26	1.496	0.655	0.14	0.665	0.065	2,550.08	18.513
3.	T2	KCl	100mM	83.25	89.5	12.79	8.61	21.41	1.537	0.557	0.095	0.543	0.058	1,917.03	13.64
4.	T3	KCl	150mM	82.75	89.25	12.23	8.28	20.51	1.514	0.543	0.095	0.483	0.055	1,830.87	13.398
5.	T4	$CaCl_2$	50mM	**88**	**94.5**	**18.72**	**12.23**	**30.95**	**1.635**	**0.763**	**0.158**	**0.848**	**0.088**	**2,926.56**	**23.155**
6.	T5	$CaCl_2$	100mM	83.5	89.75	16.69	11.54	28.23	1.553	0.645	0.138	0.658	0.065	2,533.72	18.2
7.	T6	$CaCl_2$	150mM	82.75	89	13.13	9.76	22.88	1.374	0.585	0.11	0.555	0.058	2,037.39	14.918
8.	T7	NaCl	50mM	85.5	92.75	13.32	10.35	23.67	1.312	0.633	0.128	0.633	0.06	2,195.16	17.403
9.	T8	NaCl	100mM	83	89.5	11.9	7.7	19.59	1.581	0.528	0.09	0.448	0.055	1,753.28	12.985
10.	T9	NaCl	150mM	82.5	88.5	6.96	6.50	13.47	1.092	0.51	0.07	0.425	0.055	1,191.55	11.06
11.	T10	$MgCl_2$	50mM	82.25	87.75	16.97	11.68	28.65	1.503	0.665	0.148	0.728	0.065	2,513.91	18.645
12.	T11	$MgCl_2$	100mM	81.75	86.5	14.3	11.26	25.56	1.354	0.643	0.13	0.643	0.063	2,211.45	16.643
13.	T12	$MgCl_2$	150mM	80.75	86.25	13.19	9.95	23.14	1.359	0.61	0.115	0.593	0.06	1,995.96	15.093
MEAN				83.365	89.50	14.19	10.096	24.284	1.448	0.617	0.121	0.613	0.063	2177.156	16.419
MIN				80.750	86.25	6.96	6.50	13.465	1.092	0.510	0.070	0.425	0.055	1191.553	11.060
MAX				88.00	94.50	18.72	12.23	30.950	1.635	0.763	0.158	0.848	0.088	2926.560	23.155
C.V.				2.447	1.923	6.211	8.61	5.765	8.182	7.937	13.434	5.977	12.771	6.581	9.98
SE(m)				1.02	0.86	0.411	0.435	0.7	0.059	0.024	0.008	0.018	0.004	71.638	0.82
SE(d)				1.442	1.217	0.623	0.615	0.99	0.084	0.035	0.011	0.026	0.006	101.311	1.16
C.D.				2.928	2.471	1.265	1.248	2.01	0.17	0.07	0.023	0.053	0.011	205.695	2.354

CONCLUSION

From the present investigation it is concluded that with the increase of salinity there is a significant decrease in germination and seedling growth. Among the various seed treatment treating the seed with $CaCl_2$ 50 mM for 12 hours was found to be more effective.

The study clearly indicated that $CaCl_2$ 50 mM salt treatment was superior to other treatments based on its positive effects on germination and seedling traits. That is Germination energy (88%), germination percentage (94.50%), root length (18.72 cm), shoot length (12.22 cm), seedling length (30.95 cm), root – shoot ratio (1.63 cm), root fresh weight (0.76 gm), root dry weight (0.15 gm), shoot fresh weight (0.84 gm), shoot dry weight (0.08 gm), seedling vigour index I (2926.56), seedling vigour index II (23.15) found highest in T_4 treatment than all other treatments.

FUTURE SCOPE

it is necessary to conduct more research work to increase resistance of salt-sensitive plants such as sheep fescue by using suitable calcium fertilizers in soil and water or pretreating seeds with appropriate concentrations of calcium chloride in the stages of seed germination and early growth of seedlings. Such treatments may promise more stability of this plant species in saline environments.

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Conflict of Interest. None.

REFERENCES

Aloui, H., Souguir, M., and Hannachi, C. (2014). Effect of salt stress (NaCl)on germination and early seedling parameters of three pepper cultivars (*Capsicum annuum* L.). *Journal of Stress Physiology and Biochemistry, 10*(1), 14-25.

Al-Moaikal, R. M. S. (2006). Physiological effects of gibberellic acid and polyamine (s) on germination and seedling growth of *Zea mays* stressed with sodium chloride salinity. Ph.D. Thesis, Botany Dept., Sci. College Girls, Dammam. S.A.K.

Bernstein, N. (2013). Effects of Salinity on Root Growth. Plant Roots: The Hidden Half. 10.1201/b14550-42.

Carlos, T. B. and Bingham, F. T. (1973). Salt tolerance of Mexican wheat: 1. Effect of NO_3 on mineral nutrition, growth and grain production of four wheats *Soil Science Society of America Journal, 37*: 711-715.

Chauhan, A., Rajput, N., Kumar, D., Kumar, A. and Chaudhry, A. K. (2016). Effect of different salt concentration on seed germination and seedling growth of different varieties of oat (*Avena sativa* L.) *International Journal of Info Research and Review, 3*(7), 2627-2632.

Chen, X., Zhang, R., Xing, Y., Jiang, B., Li, B., and Xu, X. (2021). The efficacy of different seed priming agents for promoting sorghum germination under salt stress. *PLOS ONE, 16*(1), 0245505.

Dehnavi, A. R., Morteza Z., Agnieszka, L., Stefany, P., Agnieszka, P. (2020). Effect of Salinity on Seed Germination and Seedling Development of Sorghum (*Sorghum bicolor* (L.) Moench) Genotypes. *Agronomy*, 10.

Farooq, M., Hussain, M., Wakeel, A. and Siddique K. H. M. (2015). Salt stress in maize: effects, resistance mechanisms, and management, a review. *Agronomy for Sustainable Development, 35*, 461-481.

Gill, P. K., Sharma, A. D., Singh, P. and Bhullar, S. S. (2001). Effect of various abiotic stresses on the growth, soluble sugars and water relations of sorghum seedlings grown in light and darkness. *Bulgarian Journal Plant Physiology, 27*(1-2), 72-84.

Hamid, M., Ashraf, M. Y. and Arashad, M. (2008). Influence of salicylic acid seed priming on growth and some biochemical attributes in wheat grown under saline conditions. *Pakistan Journal of Botany, 40*, 361-367.

Hassen, K. A. K. (1999). Effect of salinity on germination, growth and ionic content of three varieties of barley as screening tool. *Pakistan Journal of Botany, 44*(1), 47-52.

Hessini, K., Ferchichi, S., Youssef, S., Hans-Werner, K., Cruz, C., Gandour, M. (2015). How does salinity duration affect growth and productivity of cultivated barley. *Agronomy Journal, 107*, 174-180.

https://www.pjtsau.edu.in/files/AgriMkt/2020/may/KPSF Jowar May 2020.pdf

Ibrahim, A. H., Abdel-Fattah, G. M., Eman, F. M., Abd El-Aziz, M. H., and Shohr, A. E. (2011). Arbuscular mycorrhizal fungi and spermine alleviate the adverse effects of salinity stress on electrolyte leakage and productivity of wheat plants. *Phyton, 51*, 261–268.

Islam, M. S., Akhter, M. M., Sabagh, A. EL., Liu, L. Y., Nguyen, N. T., Ueda, A., Masaoka Y., and Saneoka, H. (2011). Comparative studies on growth and physiological responses to saline and alkaline stresses of Foxtail millet (*Setaria italica* L.) and Proso millet (*Panicum miliaceum* L.). *Australian Journal of Crop Science, 5*, 1269–1277.

Kandil, A., Sharief, A., Abido, W., and Ibrahim, M. M. (2012). Effect of salinity on seed germination and seedling characters of some forage sorghum cultivars. *International Journal of Agriculture Sciences, 4*, 306-311.

Kawasaki, T., Akiba, T., and Moritsugu, M. (1983). Effects of high concentrations of sodium chloride and polyethylene glycol on the growth and ion absorption in plants: I. Water culture experiments in a greenhouse. *Plant Soil, 75*, 75-85.

Khan, A. H., Ashraf, M. Y. and Azmi, A. R. (1990). Effect of sodium chloride on growth and nitrogen metabolism of Sorghum. *Acta Physiology Plantarum, 12*, 233-238.

Khan, M. I. R., Iqbal, N., Masood, A. and Khan, N. A. (2012). Variation in salt tolerance of wheat cultivars: Role of glycinebetaine and ethylene. *Pedosphere, 22*(6), 746–754.

Munns, R. (2002). Comparative Physiology of Salt and Water Stress. *Plant, cell & environment, 25*, 239-250.

Munns, R., & Tester, M. (2008). Mechanisms of salinity tolerance. *Annual Review of Plant Biology*, 59, 651-681.

Potters, G., Pasternak, T., Guisez, Y., Palme, K., Jansen, M. (2007). Stress-induced morphogenic responses: growing out of trouble. *Trends in Plant Science, 12,* 98-105.

Rani, R. (2011). Salt stress tolerance and stress proteins in pearl millet (*Pennisetum glaucum* (L.) r. br.). *Journal of Applied Pharmaceutical Science, 1*, 185-188.

Spandana, R., Chaurasia, A., Singh, V., Pashwan, V., and Dileep, R. (2021). Impact of salinity stress on seed quality parameters and its mitigation through seed quality enhancement in blackgram seeds (*Vigna mungo* L.). *Biological Forum – An International Journal, 13*(3), 33-37.

Sun, F., Zhang, W., Hu, H., Li, B., Wang, Y., Zhao, Y. Li, K., Liu, M., Li, X. (2008). Salt modulates gravity signaling pathway to regulate growth direction of primary roots in Arabidopsis. *Plant Physiology, 146*, 178–188.

Watson, K. D. S. (2022) — Medically reviewed by Kathy W. Warwick, R.D., CDE, Nutrition.

Xue, Z., Zhao, S., Gao, H. And Sun, S. (2014). The salt resistance of wild soybean (*Glycine soja* Sieb. et Zucc. ZYD 03262) under NaCl stress is mainly determined by Na+ distribution in the plant. *Acta Physiologiae Plantarum, 36*, 61–70.

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