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# Effect of Seed Priming on Physiological characteristics of Maize under Imposed Salinity Stress

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**ABSTRACT: Soil salinity is one of the major abiotic stresses that adversely affect the seed germination, seedling growth, and crop production in arid and semi-arid regions. Maize is vulnerable to salinity both in the seedling and vegetative stages and they undergo difficulties during germination and the problem of salinity is further increased because of the use of poor-quality water for irrigation and poor drainage. The deleterious effects of salt stress on seed germination can be effectively moderated by seed priming. However few studies have been conducted to compared the effects of different types of seed priming include hydro-priming, halo and osmopriming, hormonal priming, bio-priming, matrix priming and thermos priming on maize germination and growth under salt stress. In the present study, we evaluated the physiological effects of seed priming with NaCl, KCl, and $CaCl_2.2H_2O$ of various concentrations on maize under salt stress. The physiological characteristics like germination percentage, seedling vigor index, root length, shoot length, shoot to root ratio were reduced by salinity stress. Different priming treatments alleviated the impact of salt stress on maize to varying degrees. The type of priming agent and solution concentration had a significant impact on mitigation and seed priming with 100 and 200 mM.L$^{-1}$ of $CaCl_2.2H_2O$ were more effective and seed priming with 100 mM.L$^{-1}$ of NaCl were least effective under salinity. Thus, seed priming with $CaCl_2.2H_2O$ solution could be effective to improve the germination and growth of maize under saline stress conditions.**

**Keywords:** Maize, priming agents, seed priming, salinity and seed germination.

## INTRODUCTION

Salinity is one of the major concerns with irrigated land of the arid and semi-arid areas in the world. Currently, there is about 275 million hectares of irrigated land of which 20% is affected by salinity, and it this is a growing challenge for agricultural production (Ghassemi *et al*., 1995). Saline soil contains a large amount of soluble salts and sodium ions that create various physiological disorders in plants. Elevated soil salinity impairs water intake, causes nutritional disparity, causes senescence of leaves due to the accumulation of ion in the older leaves and inhibit photosynthetic efficiency in plants (Okon, 2019). Maize is a moderately salt-sensitive crop (Carpıcı *et al*., 2009). Cultivation of maize under saline soil conditions affects seed germination, seedling establishment and ultimately reduces the yield. Salt tolerance in maize can be induced by priming maize seeds with chloride salts (Ashraf and Rauf 2001). Under saline conditions plants acquire ions more quickly and the excess ion accumulation causes leaf damage and progressive death of plant (Munns, 2002). Ion imbalance due to ion accumulation caused by salt stress show their negative implications on plant growth and development by reduction in germination percentage, shoot and root growth.

Seed priming is a successful tool used to improve seed germination and crop establishment in salt effected areas. This method is easy to use, low risk technique and cost-effective for resource-poor farmers and farming systems (Harris *et al*., 2002). Seed priming stimulates various biochemical changes (water imbibition, breaking of dormancy, activation of certain enzymes) in the seed that are essential to initiate the germination process (Ajouri *et al.*, 2004).

Seed priming with chloride salts enhances the rate and uniformity of seed emergence, germination percentage as well as growth, particularly under saline conditions (Bradford, 1986; Sivritepe *et al.* 2003) and the effect of priming is greater when applied to seeds rather than applied at seedling stage (Sedghi *et al.*, 2010). In order to better understand plant salt tolerance, it may suggest to analyse the physiological changes in plants related to priming since it may offer suggestions for how plants can develop salt tolerance. In order to better understand the salt tolerance in plants, it may be useful to analyse the physiological changes in plants related to priming since it may suggest strategies for how plants can develop salt tolerance. Therefore, the present study was conducted to explore the effects of seed priming on growth parameters of maize plants under imposed salinity stress condition.

## MATERIALS AND METHODS

The study was conducted in Net house, Department of crop physiology, Agricultural college, Bapatla. It is located at 15°89′ N latitude and 80°47′ E longitude, at an altitude of altitude of 8 meters above sea level. The annual temperature of the area ranges from a minimum average of 21.69°C to a maximum average of about 32.32°C, and the mean annual rainfall during the crop period was 60.3 mm distributed in one day.

**Seed Materials and Priming.** Maize seeds (Pioneer 3396) were obtained from the certified seed supplier of Guntur seed enterpriser (GSE) store located in Guntur.

Seeds were graded and the big and uniform shaped seeds were used for priming. The seeds were surface sterilized (disinfected) with sodium hypochlorite ($Na_2HCl$) solution for 3 min and then thoroughly washed for 5 min with distilled water. Subsequently the inorganic salts $CaCl_2$ $2H_2O$, KCl, and NaCl were used as priming agents and a 100 and 200 mmol/L solution of each salt was used for seed priming. Priming of seeds with distilled water (DW) served as the control. Healthy maize seeds were primed separately in 100 mL of the different inorganic salt solutions, as well as in distilled water, for 12 h at room temperature (Plate 1). After priming, seeds were removed and washed with tap water and then rinsed three times in distilled water. Finally, seeds were left in air between two filter papers to re-dry to their original moisture level (Afzal *et al*. 2008).

**Experimental details and Design.** The study was carried out from January 01, 2022 to January 31, 2022. The experiment was conducted in completely randomized design (CRD) with 7 treatments *viz*., normal water irrigated (control-$T_1$), 100 mmol $L^{-1}$ of NaCl ($T_2$), 200 mmol $L^{-1}$ of NaCl ($T_3$), 100 mmol $L^{-1}$ of KCl ($T_4$), 200 mmol $L^{-1}$ of KCl ($T_5$),100 mmol $L^{-1}$ of $CaCl_2.2H_2O$ ($T_6$) and 200 mmol $L^{-1}$ of $CaCl_2.2H_2O$ ($T_7$) respectively, and replicated thrice.

Twenty-one cemented pots (50×40 cm) were filled with well dried soil collected from the surface a saline field with the Ec of 5 dS $m^{-1}$ and manure fertilizer, respectively. The pots were drilled to have bottom water drainage and side aeration holes and the bottom of each pot was lined with drainage sand to keep the soil well drained. After priming, 15 maize seeds of each treatment were sown directly in each pot at 2 cm depth in respective pots and the plants were thinned out to four in each pot after 10 days after emergence. The pots were irrigated according to the crop requirement.

Data was recorded on germination percentage, root length, shoot length and seedling vigor. The number seeds germinated were recorded every day. After 15 and 30 days of sowing, five seedlings were randomly selected from each replication for measurement of shoot length (SL), root length (RL) and seedling vigor, and the mean was calculated. Root length was measured from the tip of the primary root to base of hypocotyle and the shoot length was measured form the tip of the primary leaf to the base of the hypocotyle with the help of a scale and was expressed in centimetre. The germination percentage and seedling vigor index (VI) were collected according to the following formulae.

$$\text{Germination percent (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Seedling vigour index = Germination (%) × [Root length (cm) + Shoot length (cm)]

**Statistical Analysis.** The data were analyzed statistically following analysis of variance (ANOVA) technique suggested by Panse and Sukhathme (1978) for completely randomized design (CRD). The statistical hypothesis of equalities of treatment mean was tested by F- test in ANOVA at 5 per cent level of significance. Critical difference was correlated at 5 per cent level of significance at compare different treatment means.

## RESULTS AND DISCUSSION

**Effect of priming on germination percentage (%).** Priming of seeds showed significant effect on germination percentage of maize in pots (Table 1 and Fig 1). Among different seed priming treatments, the seeds primed with $CaCl_2$. $2H_2O$ 200 mmol $L^{-1}$ ($T_7$) recorded the highest germination percentage which was on par with $CaCl_2$. $2H_2O$ 100 mmol $L^{-1}$ ($T_6$) of 14.2 % and 10.6 % respectively over control. Seed priming with calcium helps in activation of metabolic processes that prepare the seeds for radical protrusion and seed germination. The above results are in harmony with findings of Kulkarni (1988), who reported that seed priming with water and also with $CaCl_2$ @ 2 % significantly increased the germination percentage over untreated seeds.

**Effect of seed priming on root and shoot length (cm).** Data regarding root and shoot length were presented in Table 2 and Fig. 2 and 3. Mean of the maize root and shoot length was significantly affected by seed priming and salinity. The reduction in shoot length was highly noticeable in control than the primed treatments. Seed priming with $CaCl_2$. $2H_2O$ 200 mmol $L^{-1}$ ($T_7$) recorded the highest root and shoot length of 25 and 24.5 % which was with $CaCl_2$. $2H_2O$ 100 mmol $L^{-1}$ ($T_6$) of 20 and 19.8 % respectively at 15 days after sowing. The lowest root and shoot length were recorded by control ($T_1$- 12.0 cm and 42.5 cm) respectively.

At 30 DAS, seeds priming with $CaCl_2$. $2H_2O$ 200 mmol $L^{-1}$ ($T_7$) recorded the highest root and shoot length of 23.8 cm and 57.4 cm, which was on par with $CaCl_2$. $2H_2O$ 100 mmol $L^{-1}$ ($T_6$) of 23.1 cm and 56.9 cm respectively. The increase in root and shoot length of maize plants for primed seeds were the result of osmopriming that reduces imbibitional rate, which causes cell wall to be more extensible and to undergo higher metabolic activities. The positive effects of priming on root and shoot lengths have been also reported by (Vajanti *et al*., 2013).

**Table 1: Effect of seed priming on germination % and seedling vigor in maize under imposed salinity stress (Ec-5 dS $m^{-1}$)**

| Treatment | Germination % | seedling vigor | |
|---|---|---|---|
| | | 15 DAS | 30 DAS |
| **$T_1$** - control | 84 | 1883.28 | 4796.40 |
| **$T_2$** - 100 mmol $L^{-1}$ of NaCl | 86 | 2175.80 | 5515.20 |
| **$T_3$** - 200 mmol $L^{-1}$ of NaCl | 86 | 2296.20 | 5813.02 |
| **$T_4$** - 100 mmol $L^{-1}$ of KCl | 88 | 2489.13 | 5602.69 |
| **$T_5$** - 200 mmol $L^{-1}$ of KCl | 89 | 2536.50 | 6363.50 |
| **$T_6$** - 100 mmol $L^{-1}$ of $CaCl_2.2H_2O$ | 94 | 2754.20 | 7520.04 |
| **$T_7$** - 200 mmol $L^{-1}$ of $CaCl_2.2H_2O$ | 98 | 2989.00 | 7956.39 |
| CD (p=0.05) | **6.10** | **188.16** | **283.41** |
| CV (%) | **3.90** | **4.39** | **2.60** |
| SE.m± | **2.01** | **62.03** | **93.44** |

**Table 2: Effect of seed priming on shoot and root length (cm) in maize under imposed salinity stress (Ec- 5 dS $m^{-1}$).**

| Treatment | root length | | Shoot length | |
|---|---|---|---|---|
| **Days after sowing** | 15 DAS | 30 DAS | 15 DAS | 30 DAS |
| **$T_1$** - control | 10.4 | 14.5 | 12.0 | 42.5 |
| **$T_2$** - 100 mM.$L^{-1}$ of NaCl | 12.2 | 16.2 | 13.1 | 47.9 |
| **$T_3$** - 200 mM.$L^{-1}$ of NaCl | 12.8 | 18.6 | 13.9 | 49.0 |
| **$T_4$** - 100 mM.$L^{-1}$ of KCl | 13.9 | 19.4 | 14.4 | 44.3 |
| **$T_5$** - 200 mM.$L^{-1}$ of KCl | 14.1 | 19.5 | 14.5 | 52.0 |
| **$T_6$** - 100 mM.$L^{-1}$ of $CaCl_2.2H_2O$ | 14.2 | 23.1 | 15.1 | 56.9 |
| **$T_7$** - 200 mM.$L^{-1}$ of $CaCl_2.2H_2O$ | 14.8 | 23.8 | 15.7 | 57.4 |
| CD (p=0.05) | **0.9** | **4.1** | **1.1** | **3.5** |
| CV (%) | **3.91** | **11.91** | **4.58** | **3.96** |
| SE.m± | **0.3** | **1.3** | **0.4** | **1.1** |

**Effect of seed priming on seedling vigor.** Seedling vigor was significantly ($p$<0.05) affected by seed priming. The data pertaining to the effect of seed priming on seedling vigor were presented in Table 1 and Fig. 4.

Seeds primed with $CaCl_2$. $2H_2O$ 200 mmol $L^{-1}$ ($T_7$) had higher seedling vigor than those treated with other salts solutions and control at both 15 and 30 days after sowing. In addition, $CaCl_2$. $2H_2O$ 100 mmol $L^{-1}$ ($T_6$) was also effective in alleviating the adverse effect of salinity on seedling vigor compared with the seeds treated with water. Seed priming with $CaCl_2$. $2H_2O$ 200 mmol $L^{-1}$ ($T_7$) recorded 27.3 and 29 per cent higher seedling vigour than control at both 15 and 30 days after sowing. It might be due to rapid uniform germination and genetic potential to have good seedling vigor. The positive effects of seed priming on seedling vigour and seed quality were also reported in rape seed (Golizadeh *et al*., 2015). Ratkanta and Kalipada (2013) reported that seed priming with calcium chloride solutions (2%) can help seeds to germinate more quickly and more uniformity while also improving their vigour.

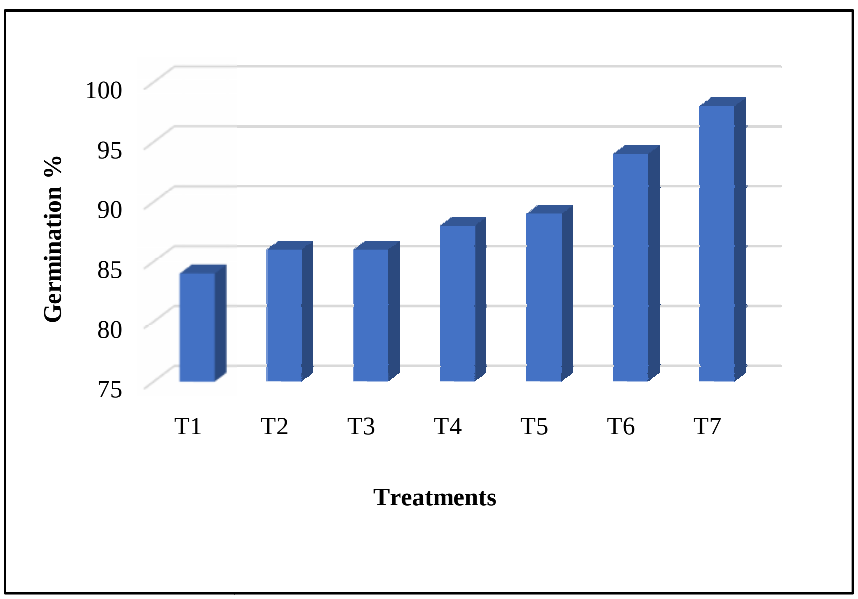


**Fig. 1.** Germination % of maize as influenced by seed priming under salinity stress.

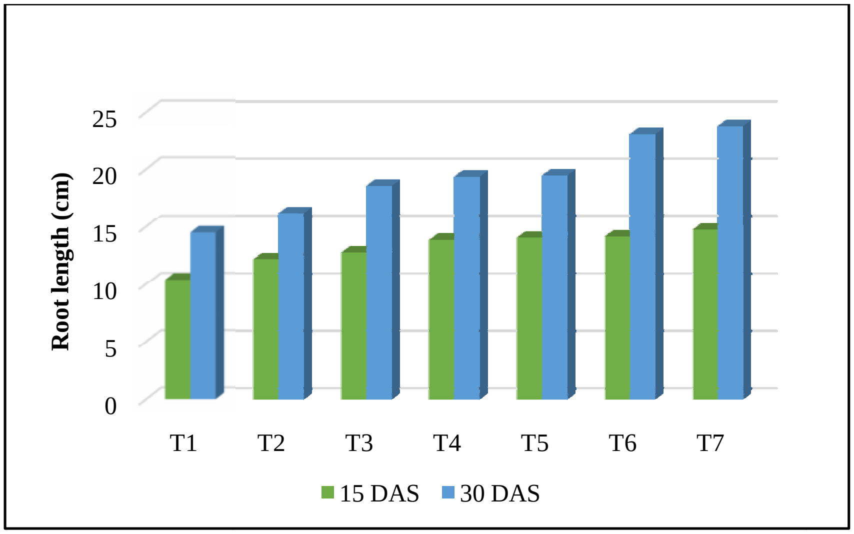


**Fig. 2.** Root length (cm) of maize as influence by seed priming under salinity stress.

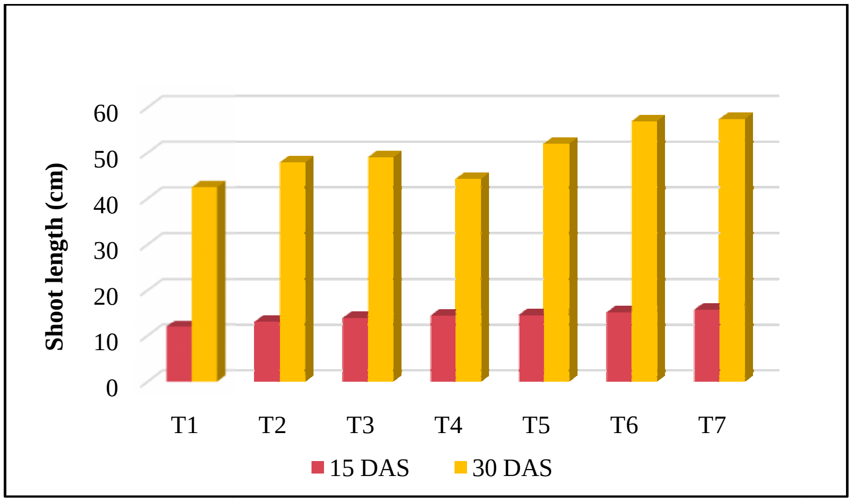


**Fig. 3.** Shoot length (cm) of maize as influence by seed priming under salinity stress.

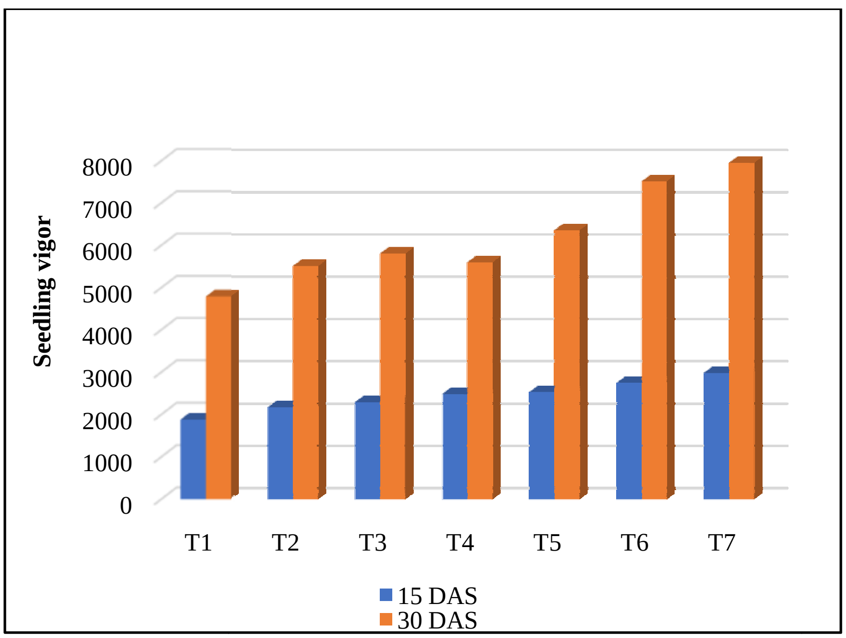


**Fig. 4.** Seedling vigor of maize as influence by seed priming under salinity stress.

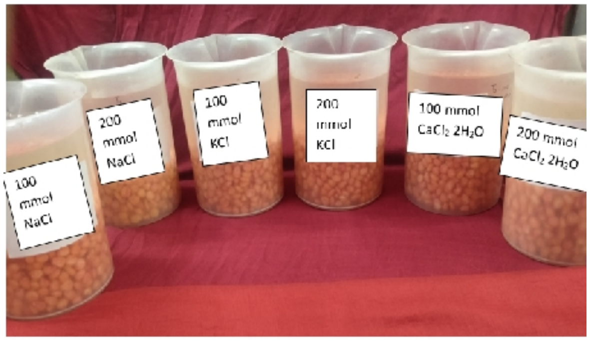


**Plate 1.** Seed priming in maize with different priming agents and comcentrations.

## CONCLUSION

Salinity inhibits the growth of maize seeds at their early stages. Priming is a practical way for farmers with salinity-stressed agricultural fields to meet their needs. $CaCl_2$. $2H_2O$ was found to be the most successful at imparting salt tolerance in maize at the early growth stages among the several chloride salts used for priming maize seeds. In this experiment, the better performance of the primed seeds on germination percentage, seedling vigor, shoot and root length shows the appraise of priming in saline soils. Additional advanced research is also required to investigate the effects of seed priming on physiological and biochemical attributes at different growth stages and yield of maize.

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**Conflict of Interest**. None.

## REFERENCES

Afzal, I., Rauf, S., Basra, S. M. A. and Murtaza, G. (2008). Halopriming improves vigor, metabolism of reserves and ionic contents in wheat seedlings under salt stress. *Plant Soil Environ.*, *54*(9): 382-388.

Ajouri, A., Asgedom, H. and Becker, M. (2004). Seed priming enhances germination and seedling growth of barley under conditions of P and Zn deficiency. *Journal of Plant Nutrition and Soil Science*, *167*(5): 630-636.

Ashraf, M. and Rauf, H. (2001). Inducing salt tolerance in maize (*Zea mays* L.) through seed priming with chloride salts: Growth and ion transport at early growth stages. *Acta Physiologiae Plantarum*, *23*(4): 407-414.

Bradford, K. J. (1986). Manipulation of seed water relations via osmotic priming to improve germination under stress. *Hort Science*, *21*(5): 1105-1112.

Carpýcý, E. B., Celýk, N. and Bayram, G. (2009). Effects of salt stress on germination of some maize (Zea mays L.) cultivars. *African Journal of Biotechnology*, *8*(19).

Farooq, M., Basra, S. M. A., Khalid, M., Tabassum, R. and Mahmood, T. (2006). Nutrient homeostasis, metabolism of reserves, and seedling vigor as affected by seed priming in coarse rice. *Botany*, *84*(8): 1196-1202.

Ghassemi, F., Jakeman, A. J. and Nix, H. A. (1995). Salinisation of land and water resources: human causes, extent, management and case studies. *CAB international*.

Golizadeh, S. K., Mahmoodi, T. M. and Khaliliaqdam, N. (2015). Effect of Priming of ($KNO_3$, $ZnSO_4$, Distilled water) on rate Germination and Seedling Establishment on Cannabis seed (*Cannabis sativa* L.). *Biological Forum-An International Journal, 7*(1): 190.

Harris, D., Tripathi, R. S. and Joshi, A. (2002). On-farm seed priming to improve crop establishment and yield in dry direct-seeded rice. *Direct seeding: Research Strategies and Opportunities, International Research Institute, Manila, Philippines*, 231-240.

Kulkarni, N. G. (1988). Effect of pre-soaking of maize seeds on seed quality. *Seed. Res*., *16*(1): 37-40.

Munns, R. (2002). Comparative physiology of salt and water stress. *Plant, cell & environment*, *25*(2): 239-250.

Okon, O. G. (2019). Effect of salinity on physiological processes in plants. In *Microorganisms in saline environments: strategies and functions*. 237-262. Springer, Cham.

Panse, V. C. and Sukhatme, P. V. (1978). Statistical methods for Agricultural workers. III Rev. *Ed. ICAR, New Delhi*.

Ratkanta, M. and Kalipada, P. (2013). Vegetable seed priming: A low cost, simple and powerful techniques for farmers' livelihood. *International Journal of Bio-resource and Stress Management*, *4*(4): 475-481.

Sedghi, M., Nemati, A. and Esmaielpour, B. (2010). Effect of seed priming on germination and seedling growth of two medicinal plants under salinity. *Emirates Journal of Food and Agriculture*, 130-139.

Sivritepe, N., Sivritepe, H. O. and Eris, A. (2003). The effects of NaCl priming on salt tolerance in melon seedlings grown under saline conditions. *Scientia horticulturae*, *97*(3-4): 229-237.

Vajanti M., Pahoja, S., Siddiqui, S., Narejo, H. and Umrani, J. H. (2013). Response of hydropriming and osmopriming on germination and seedling growth of sunflower (*Helianthus annus* L.) under salt stress. *International Journal of Agricultural Science and Research*, *3*(2): 71-80.

ri Babu M., Vijaya Kumar G., Anny Mrudhula K. and Ratna Kumari S. (2022). Effect
ristics of Maize under Imposed Salinity Stress. *Biological Forum – An International*