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Effects of Seed Priming on Seedling Growth of Isabgol under Salinity Stress

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ABSTRACT

Background: Salinity stress is one of the most severe problems in agriculture. Seed priming is a technique that improves seed germination and growth under abiotic stress. The study was conducted to evaluate the effects of different seed priming agents on seedling growth of Isabgol (*Plantago ovata* Forsk) Variety GI-3 under salinity stress.

Methods: The experiment was conducted with a completely randomized design. The factors examined include four types of priming, control (unprimed seeds) with Salicylic acid, KNO_3 and Gibberellic acid, with two salinity levels (0 and 5.3 dS/m), respectively.

Result: In this experiment, germination traits like germination percentage, Mean Germination Time, plumule length, radicle length, seed vigour and fresh weight were measured. Data were analysed by using SPSS software. The present study shows that although all priming treatments were effective at the germination stage, but KNO_3 was proved to be the most effective since it significantly increased germination performance than other priming treatments.

Key words: Germination, *Plantago ovata* Forsk, Seed priming, Salinity stress.

INTRODUCTION

Isabgol (*Plantago ovata* Forsk.) is an annual species grown in the arid and semi-arid regions and is used widely in traditional and Industrial Pharmacology (Patel *et al.,* 1996; Mahdavi, 2013). Salinity is one of the significant abiotic stresses, limits crop growth and production. Additionally, secondary salinization caused by poor irrigation and/or drainage practices is a continuing natural process in agriculture (Shabala, 2013; Qadir *et al.,* 2014; Shaikh-Abol-hasani and Roshandel, 2019). Bray (2000) reported that salinity has been a restricting factor that affects all plant growth stages. Germination failure in saline soils results from high salt concentrations in the seed planting zone because of the upward movement of soil solution and subsequently evaporation of the soil surfaces. This has been attributed to both osmotic and toxic effects (Song *et al.,* 2005; Farahbaksh and Pour, 2012; Nedjimi, 2013).

Seed priming is one of the biological strategies by which salinity tolerance of potential crops can be increased. In priming seeds are exposed to restricted water availability under controlled conditions which allow some of the physiological processes to occurs before complete germination (Sharma *et al.,* 2014; Gholami, Mokhtarian and Baninasab, 2015). The main advantage of this technique is the plant protection against diseases and pests and also reduction in the use of fertilizers and pesticides. Therefore, the farmer can reach a crop with more quality and quantity with expensing less time, cost and effort (Fehhenabi, 2007; Hoseini, Kouchebagh and Jahandidet, 2013). Demir and Mavi (2004) found watermelon seed priming with KNO_3 solution effectively improved germination and seedling growth of the seeds under salinity compared to non-primed seeds. Cayuela *et al.,* (1996) found that tomato seed priming improves germination, seedling emergence and seedling growth under saline conditions.

Seed priming provides faster and synchronized seed germination and growth. Therefore, the present study was conducted to study the effects of seed priming on seedling growth of *Plantago ovata* Forsk. var. GI-3 under salinity stress.

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MATERIALS AND METHODS

Plant material

Seeds of *Plantago ovata* Forsk. var. GI-3 obtained from seed Spices Research Station, Jagudan, Gujarat, served as the primary material for the present experimentation.

Salt screening test

To determine the threshold level of salt concentration at which GI-3 seed germination decreased, solution of NaCl were prepared for the different EC of 0, 4.2, 4.6, 5.1, 5.3 dS/m. Seeds were surfaced sterilized with 5% of sodium hypochlorite for 2 minutes. 20 seeds of GI-3 were placed in

Petri dishes (100 ×15 mm) with Whatman's Filter Paper No. 2. Each dish was moistened with uniforms amounts of desired salinity level. Petri dishes were placed at room temperature in the laboratory. 5 ml of the appropriate solutions were added every alternate day to each petri dish. Seeds were considered germinated once the radicle was at least 2mm long. The final germination percentage was determined after 7 days. There was 60% reduction in germination percentage at the salinity level of 5.3 dS/m.

Priming treatment

The seeds were sterilized with sodium hypochlorite (4%) solution for 3 minutes and dried on filter paper. Seeds were treated with the following (i) unsoaked seeds (Control); (ii) 0.5mM of Salicylic acid (T1) for 22 h; (iii) 10% KNO_3 (T2) for 22 h and (iv) 10 ppm Gibberellic acid (T3) for 22 h. Priming treatments have been shown in Fig 1. During priming, containers were kept in the dark condition and well aerated with an aquarium water pump because sufficient oxygen is required for seed respiration in osmotic seed priming. After priming, the seeds were rinsed twice with distilled water and dried to the original moisture content as the unprimed seeds and immediately used for germination test.

Seed germination experiment

The experiment was carried out in the Physiology Laboratory of the Department of Botany, University School of Sciences, Gujarat University during Rabi season of 2020-21. The experiment was conducted in completely randomized design with four replications. Two salinity levels of 0 dS/m and 5.3 dS/m have been decided from the above-mentioned salt screening. Unprimed seeds were used as control. Total 20 seeds were placed on Whatman's No. 1 filter paper per petri dish. The petri dishes were kept under lab conditions *i.e.* at 25±2°C and humidity 40%. For the salt stress 10ml of NaCl solution prepared for 5.3 dS/m has been added to the petri dish in the interval of every 2 days. Data were recorded daily on germination for 7 days. After that, data collected on various parameters such as germination percentage, mean germination time, Plumule length, Radicle length, vigour Index and fresh weight were recorded (Fig 2). Formulas used for the calculation have been mentioned below.

(a) Germination percentage (%) =

$$\frac{\text{Total number of germinated seeds}}{\text{Total seeds placed for germination}} \times 100$$

(b) Mean germination time (days)= d1/n1+d2/n2+d3/n3+……

Where,
d = Number of days.
n= Number of germinated seed.

(c) Seed vigour= Germination % * (RL+PL)

Where,
RL= Radicle length.
PL=Plumule length.

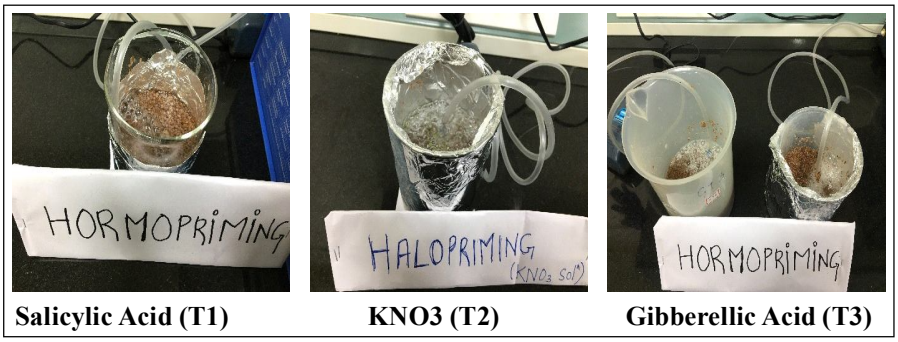

Fig 1: Seed priming treatments given to seeds of Gujarat Isabgol-3.

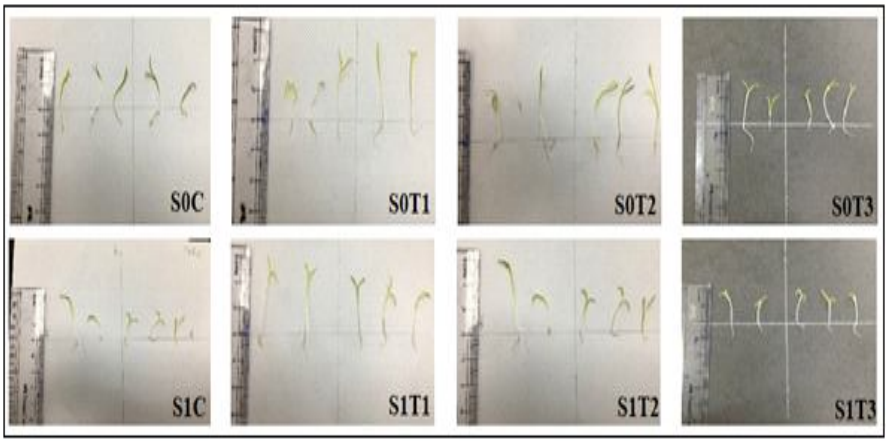

Fig 2: GI-3 showing plumule and radicle length in primed seedlings to control under salinity stress (S0: 0 dS/m, S1: 5.3 dS/m).

Statistical analysis

Two-way ANOVA was performed to analyse the data by using SPSS software version 26 and means were compared with Duncan's Multiple Range Test at 5% statistical probability levels.

RESULTS AND DISCUSSION

Germination percentage

The result showed the effect of salinity and interaction of salinity with priming was significant on Isabgol seed germination percentage (Table 1). The highest germination percentage has been observed in control without salinity with an average of 91.25% (Table 2). The germination percentage of GI-3 significantly is influenced by different priming treatments under salinity stress. All the priming treatments increased the germination percentage in primed seeds over control (26.3%) under salinity stress (Fig 3); being maximum in salicylic acid (62.5%) followed by KNO_3 (60%) then gibberellic acid (45%). Munns *et al.,* (1988) stated that the reduction in germination under salinity is due to less water availability to plant roots via low osmotic potential and ionic toxicity of Na^+ and Cl^-. Salicylic acid is one of the promising priming agent which promotes germination percentage in saline condition. Similar kind of results were obtained by Afzal *et al.,* 2005, observed that Salicylic acid treatment increases germination percentage under salinity conditions. The germination percentage decreases with increased Gibberellic acid concentration, these findings are in accordance with Chauhan *et al.,* (2009) stated that higher concentration inhibits germination in Black gram and Horse Gram.

Mean germination time

Mean Germination Time of Isabgol was affected by priming (Table 1). Priming with KNO_3 has significantly reduced Mean Germination Time under saline condition *i.e*. 2.8 days as shown in Table 2. However, priming with Gibberellic acid has shown increased MGT in salt stress compared to primed seeds without any salinity stress (Fig 4). Decrease in MGT was also observed by Karimi and Varyani (2013) in Marigold and in rapeseed by Ghassemi-Golezani *et al.,* (2010).

Plumule length

Effect of priming was significant on Plumule length (Table 1). Seeds treated with Salicylic Acid and Gibberellic acid produced the higher plumule length than untreated. The highest Plumule length was observed in Salicylic Acid without salinity stress with an average of 2.325 cm (Table 2). The mean of Plumule length has not been affected by the salinity stress. Although priming with KNO_3 in salinity stress (Fig 5) significantly increased in the mean Plumule length (2.13 cm) as compared to primed seeds under no salinity stress (1.96 cm). The results are in accordance with Mavi *et al.,* (2006) and Shehzad *et al.,* (2012), who reported that priming with KNO_3 increased seedling size in tomato and sorghum.

Table 1: Analysis of variance for germination traits under salinity and priming treatments.

		Mean square					
Source	Df	GP	MGT	PL	RL	VI	FW
Salinity	1	1953.125*	3.184	0.031	1.950*	316.576	0.003
Priming	3	193.750	6.258*	1.310*	0.477*	40381.476*	0.004*
Salinity × Priming	3	2263.542*	2.175	0.087	0.117*	6129.829	0.001
Error	24	113.542	0.890	0.143	0.078	2437.485	0.001
CV%		35.04	883.9	24.46	44.23	32.14	332.4

*indicates significant difference at 5% probability level. GP- Germination percentage, MGT- Mean germination time, PL- Plumule length, RL-Radicle length, VI-Vigour and FW- Fresh weight.

Table 2: Mean comparison of the interaction between different priming treatments and Salinity stress for Gujarat Isabgol-3 seed germination traits.

Salinity	Priming treatment	GP%	MGT(d)	PL	RL	VI	FW
0 dS/m	Control	91.25a	3.8a	1.3b	0.975b	232.5a	0.0745a
	Salicylic Acid	58.75b	3.05a	2.325a	0.875ab	312.75a	0.12675a
	KNO_3	52.5b	2.937425a	1.96ab	1.655a	256.8625a	0.09575a
	Gibberellic Acid	53.75b	3.45315a	2.4a	1.325ab	204.775a	0.0947a
5.3 dS/m	Control	26.25c	5.9825a	1.6b	0.525a	195.5b	0.075b
	Salicylic Acid	62.5a	3.275b	2.25a	0.675a	351.5a	0.13075a
	KNO_3	60a	2.8659b	2.13a	0.87a	298.725a	0.1395a
	Gibberellic Acid	45b	3.640575b	2.255a	0.785a	136c	0.12375a

Means in each Column with same alphabetical letter (s) are not significantly different at 0.05 probability level according to Duncan's multiple range test: GP- Germination percentage, MGT- Mean germination time, d- days, PL- plumule length, RL- Radicle length, VI-Vigour and FW- Fresh weight.

Radicle length

Effect of Salinity, Priming and interaction of salinity with priming were significant on Radicle length (Table 1). The lowest radicle length was in control under salinity stress while the highest was achieved in KNO_3 without salinity stress (Table 2). The mean Radicle Length during the seed germination of unprimed seeds without any salinity stress is 0.98 cm, while under salinity stress, the mean radicle length of unprimed seeds declines to 0.53 cm. Priming with KNO_3 has shown an increased mean radicle length of 1.66

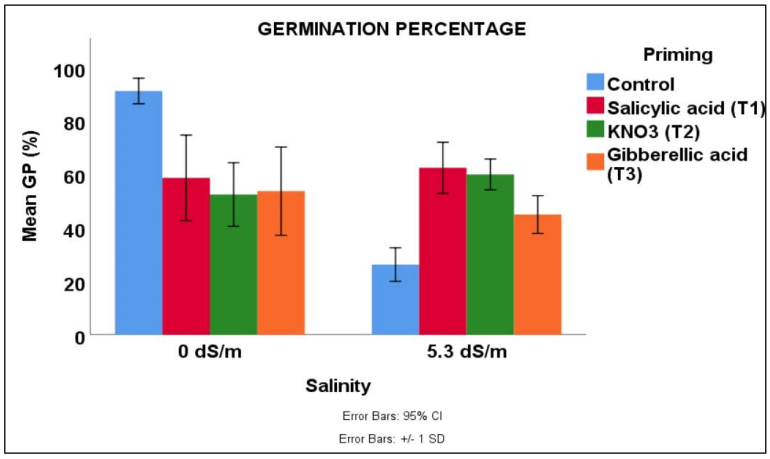

Fig 3: Effects of priming treatments on germination percentage of Isabgol seedlings.

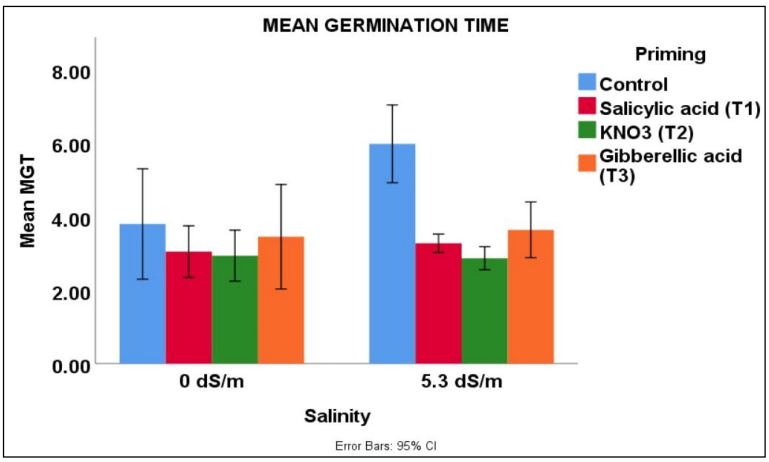

Fig 4: Effects of priming treatments on mean germination time of Isabgol seedlings.

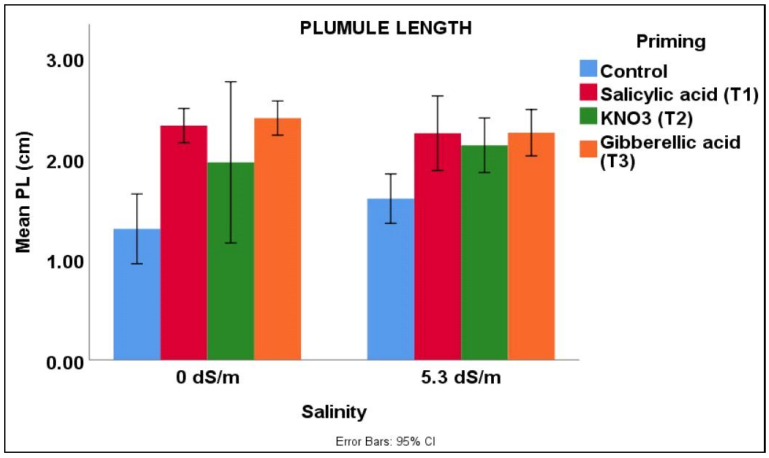

Fig 5: Effects of priming treatments on plumule length of Isabgol seedlings.

cm at 0 dS/m (Fig 6). These results confirm the finding of Stofella *et al.,* (1992), who reported that priming has significantly improved root length in pepper seeds.

Seed vigour

Priming has shown significant effect on seed vigour (Table 1). The highest seed vigour was 298.725 on an average in KNO_3 under salinity stress (Table 2). Priming with Salicylic acid-induced maximum seed vigour *i.e*. 352 under salinity stress (Fig 7). This finding is in accordance to Afzal *et al.,* (2005), who reported positive effects of priming with salicylic acid on seed vigour in Wheat under salinity stress. Priming with KNO_3 also improved vigour over the unprimed seeds under salinity stress *i.e*. 299.

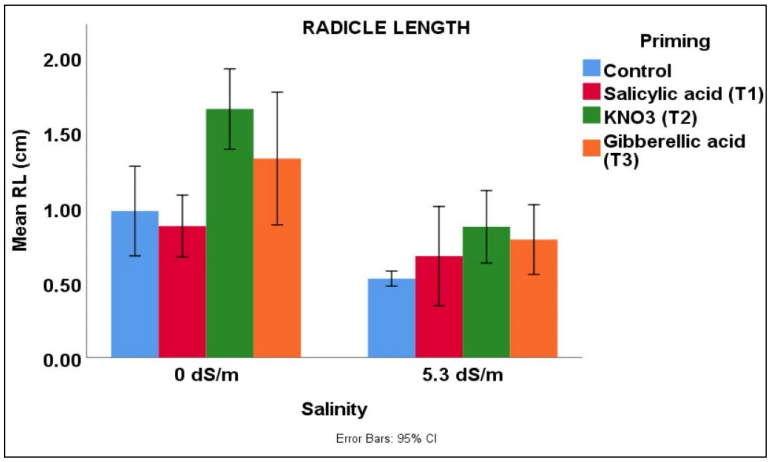

Fig 6: Effects of priming treatments on radicle length of Isabgol seedlings.

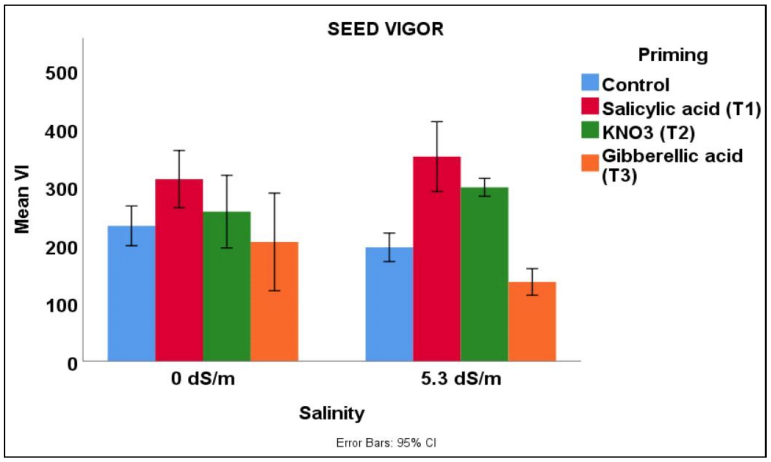

Fig 7: Effects of priming treatments on seed vigour of Isabgol seedlings.

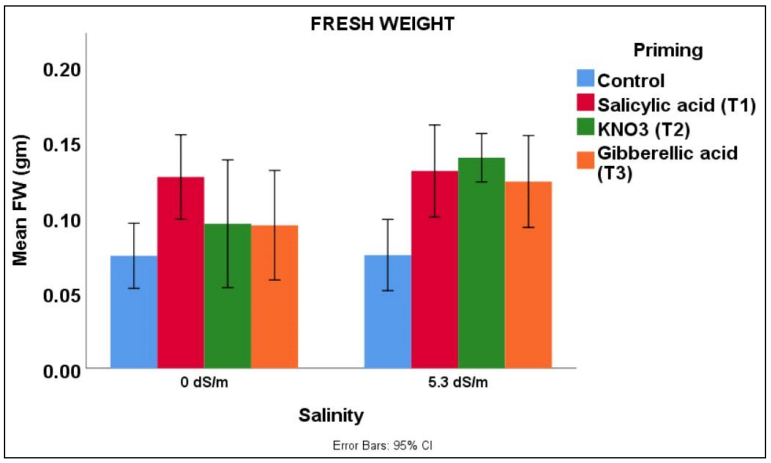

Fig 8: Effects of priming treatments on fresh weight of Isabgol seedlings.

Fresh weight

Priming has shown significant effect on Seedling fresh weight (Table 1). Seeds primed with KNO_3 produced seedling having maximum fresh weight, *i.e*. 0.139 gm followed by Gibberellic acid (0.12 gm) as shown in Fig 8. However, unprimed seeds do not show any decrease in fresh seedling weight under salinity stress. The increased fresh weight with KNO_3 was also observed by Jabeen and Ahmad (2011) in *Helianthus annus* L. and *Carthamus tinctorius* L. Similar kinds of result was also obtained by Hamayun *et al.,* (2014) who reported priming with KNO_3 has increased the fresh weight of *Glycine max* L. seedlings under saline condition.

CONCLUSION

Considering the above results obtained from the present investigation, it could be concluded that among the various priming treatments *viz*. salicylic acid, KNO_3 and gibberellic acid, KNO_3 was the most effective in alleviating the adverse effects of salt stress during seed germination of Gujarat Isabgol-3. However, after KNO_3, Salicylic acid was also influential in promoting various parameters during the germination under saline conditions. Therefore, it could be concluded that seed priming with KNO_3 and salicylic acid is an effective approach to overcome salinity in Gujarat Isabgol-3 and recommended as a pre-sowing treatment under salinity stress.

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Conflict of inetrest: None.

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