



## RESEARCH ARTICLE

## EFFECT OF SALINITY ON GERMINATION AND SEEDLING GROWTH OF MUNGBEAN

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## ABSTRACT

In southwestern coastal Bangladesh, the relative contribution of different salinity levels and mungbean varieties on mungbean production has been hardly quantified. A laboratory trial was carried out at Agronomy Laboratory, Agrotechnology Discipline, Khulna University to investigate the influence of mungbean varieties and water salinity levels on seed germination and early seedling growth during dry season (February to March, 2023). For the research, three mungbean varieties (BARI Mung-6, BARI Mung-7, BARI Mung-8) were chosen and subjected to six salinity levels (control, 3 dS m<sup>-1</sup>, 5 dS m<sup>-1</sup>, 7 dS m<sup>-1</sup>, 9 dS m<sup>-1</sup>, 11 dS m<sup>-1</sup>). The research was arranged in a factorial Completely Randomized Design (CRD). Data were collected for various germination (germination percentage, germination capacity, germination energy) and early seedling growth characters (root length, shoot length). The analysis of variance (ANOVA) technique was employed for data analysis. All the germination and seedling growth parameters varied significantly due to varieties as well as due to for salt treatments. BARI Mung-6 exhibited the best performance regarding all the studied traits among the three mungbean varieties. Salt stress caused a negative impact on various germination qualities and early seedling growth characters. However, BARI Mung-6 performed well fit for 7 dS m<sup>-1</sup> salinity level. Therefore, BARI Mung-6 could be a useful material for cultivation in the salt affected soils of southwestern coastal Bangladesh.

## KEYWORDS

Bangladesh, Mungbean, Salinity, Germination, Seedling Growth

## 1. INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is an ecologically friendly pulse species described with well adapted in arid and highland agriculture (Podder et al., 2020). As a short duration (~60 days) crop, it is considered a supreme pulse for catch cropping, intercropping, and relay cropping practices (Miajy et al., 2024). Mungbean has become a widely held legumes in the tropical and sub-tropical region for its high nutritional value (Thomas et al., 2004) and readily digestible protein for men particularly meant for the deprived wherever meat is limited (Bangar et al., 2019). It contains plenty of protein (24.5%) with extraordinary value of lysine (460 mg g<sup>-1</sup>) and tryptophan (60 mg g<sup>-1</sup>), oil (0.6%), fiber (0.9%) and embers (3.7%) (Potter and Hotchkiss, 1998). It helps to conserve soil productiveness by fixing atmospheric nitrogen to soil and hence offers a significant part in ecological agriculture (Kannaiyan, 2016).

Even with the economic importance of the crop, the annual total production of mungbean in Bangladesh is 41000 MT having a mean yield of 930 kg ha<sup>-1</sup> (BBS, 2022) which is rather low compared to pulse producing countries in the world. Lack of premium seed of modern varieties, improper agronomic practices along with biotic and abiotic stresses are accountable to inferior yield of mungbean in Bangladesh (Pratap et al., 2019). Amongst various edaphic factors, salinity is indeed a key limitation hindering mungbean cultivation, where up to 70% yield decline results from 50 mM NaCl (Saha et al., 2010). Salt stress intensifies the amount of various ions which undesirably disturbs smooth germination and subsequent development, mineral nutrients supply, proper growth and harvest in nearly all the crops grown by dropping the osmotic tension of water or triggering particular ionic hazard, or both

(Zahedi et al., 2012; Alom et al., 2016; Kazal et al., 2017, Miajy et al., 2017). High concentration of salt creates oxidative pressure which finally points to crop death as a result of restricted growth and cell injury (Hasanuzzaman et al., 2012).

Salinity is a vibrant environmental stress that hampers plant growth and causes significant losses in agricultural productivity (Hossain et al., 2008). In Bangladesh, about 1.056 million ha lands are affected by various degrees of salinity where the electrical conductivity (EC) values vary from 4 to 16 dS m<sup>-1</sup> and during 1973-2009, about 0.223 million ha (26.7%) of novel lands were subjected to salinity (SRDI, 2012). The increment of saline areas might be owing to the rising sea surface, coastal sinking, amplified tidal consequence and lessening of sweet water course movement (Miajy et al., 2024). The intensity of cropping in saline areas is far below the national average. The net cultivable area in coastal areas of Bangladesh has been declining over the last few decades and studies have recognized salinity as the major cause for yield drop in coastal agriculture (Baten et al., 2015). It is a fact that the agricultural land of Bangladesh is declining rapidly and there is little scope for horizontal expansion of land. For ensuring food security in the country the marginal lands like salt affected areas of the coastal zone might be brought under more crop coverage for increased production. Hence, screening of salt tolerant crop varieties for cultivation in the saline areas is necessary.

Seed germination of crops is greatly impacted by the toxicity of Na<sup>+</sup> and Cl<sup>-</sup> ions, and the capability to endure this stress varies from plant to plant and also from genotype to genotype (Atak et al., 2006). Mungbean exposed to salinity at the early growth stage decreases final germination, fresh weight and dry matter yield, shoot and root sizes, and seedling vigor (Sehrawat et al., 2014). NaCl stress caused a rapid drop in features linked to root

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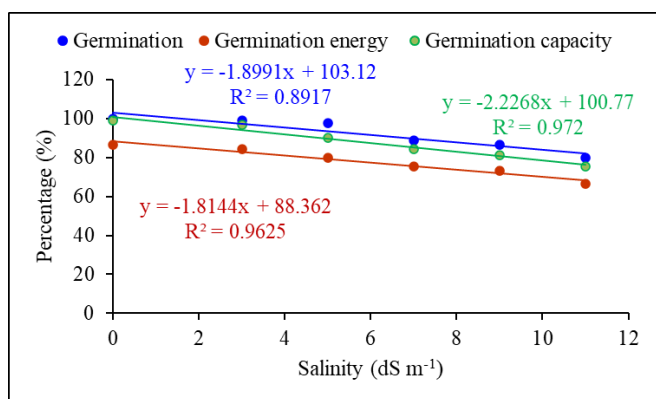


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**Figure 1:** Functional relationship between salinity and seed germination parameters in three mungbean varieties

When germination parameters were plotted against various salinity levels linear but negative relationship was found indicating that all germination traits declines with swelling salinity levels (Fig. 1). The regression equations obtained were:  $y = -1.8991x + 103.12$ ,  $R^2 = 0.8917$  (for germination);  $y = -1.8144x + 88.362$ ,  $R^2 = 0.9625$  (for germination energy) and  $y = -2.2268x + 100.77$ ,  $R^2 = 0.972$  (for germination capacity). The regression equations also suggests that reduction is the least for germination energy but the peak for germination capacity. And more than 95% ( $R^2 = 0.8917$ ,  $R^2 = 0.9625$  and  $R^2 = 0.972$ ) of the variations in germination attributes may be explained by the variation in salinity levels as revealed by the three regression equations.

The combined effect of different mungbean varieties and salt levels put forth substantial influence on germination attributes of mungbean (Table 2). Among the different treatment arrangements, the supreme germination (100%) was detected in all the three mungbean varieties in the control treatment, whereas the least amount of the feature was documented in BARI Mung-8 (73.33%) at 11 dS m<sup>-1</sup> salinity level. In BARI Mung-6 statistically similar germination percentages were recorded when

salinity was applied at 0, 3 and 5 dS m<sup>-1</sup> level, but for BARI Mung-8 germination percentages of 0 and 3 dS m<sup>-1</sup> were statistically at par. Salinity stress of 11 dS m<sup>-1</sup> decreased the germination percentage by 10, 23.33 and 26.67% in BARI Mung-6, BARI Mung-7, and BARI Mung-8, respectively in comparison to control. The supreme germination energy (96.66%) was noticed in BARI Mung-6 variety at 0 dS m<sup>-1</sup>, whereas the lowest value of the trait was obtained in BARI Mung-7 (63.33%) at 11 dS m<sup>-1</sup>. The points of drop in germination energy due to salt application were 27.59, 28.93 and 16.68% in BARI Mung-6, BARI Mung-7, and BARI Mung-8, respectively. In addition, the highest germination capacity (100%) was found in BARI Mung-6 and BARI Mung-8 at 0 and 3 dS m<sup>-1</sup>, whereas the least value of the character was obtained in BARI Mung-8 (63.33%) at 11 dS m<sup>-1</sup> salt level. The gradations of decline in germination capacity due to salinity of 11 dS m<sup>-1</sup> were 10, 26.67 and 36.67% in BARI Mung-6, BARI Mung-7, and BARI Mung-8, respectively. The findings of the present study also suggests that final germination suffers less while germination capacity suffers more owing to salinity water application.

The variation in germination capacity of mungbean genotypes under control and salt stress condition might be due to combined effects of intrinsic factors and heredity divergences (Win et al., 2011). It might be anticipated that the NaCl persuaded osmotic stress during the germination obstructs the developing attributes plus existence of mungbean as continued existence of crop in early stage on salty soils may hang on acceptance to small osmotic potential (Roundy, 1983). These antagonistic properties in germination might be owing to the decline in water captivation by seeds owing to increased salinity which reduced osmotic pressure and generate irregularities in regular water collecting processes (Bayuelo-Jiménez et al., 2002). Reducing germination rate and germination percentage might be for the extreme toxic ions (Na<sup>+</sup> and Cl<sup>-</sup>) formed in seeds at salty condition (Sanchez et al., 2014; Sehrawat et al., 2013), where salt resistant varieties display comparatively better germination by faster absorption of Na<sup>+</sup> (Zhang et al., 2010). Likewise reported that salt application reduced germination parameters in mungbean which supports our findings Sehrawat et al. (2014; Kamrul et al., 2018). Germination features were lessened with swelling salinity levels and extensively described in mungbean and other pulses (Arslan et al., 2016; Swarnakar, 2016).

**Table 2:** Combined effect of variety and salinity on germination characters of mungbean

Variety	Salinity (dS m <sup>-1</sup> )	Germination (%)	Variation over control (%)	Germination energy (%)	Variation over control (%)	Germination capacity (%)	Variation over control (%)
BARI Mung-6	0	100.00a		96.66a		100.00a	
	3	100.00a		93.33a	-3.45	100.00a	
	5	100.00a		86.66ab	-10.35	96.67ab	-3.33
	7	96.67ab	-3.33	76.66bcd	-20.70	96.67ab	-3.33
	9	96.67ab	-3.33	73.33cde	-24.14	96.67ab	-3.33
	11	90.00bc	-10.00	70.00cde	-27.59	90.00bc	-10.00
BARI Mung-7	0	100.00a		86.66ab		96.67ab	-3.33
	3	96.67ab	-3.33	80.00bc	-7.69	90.00bc	-10.00
	5	96.67ab	-3.33	76.66bcd	-11.54	86.67c	-13.33
	7	90.00bc	-10.00	76.66bcd	-11.54	83.33c	-16.67
	9	86.67cd	-13.33	73.33cde	-15.39	83.33d	-16.67
	11	76.87e	-23.33	63.33e	-28.93	73.33d	-26.67
BARI Mung-8	0	100.00a		80.00bc		100.00a	
	3	100.00a		80.00bc		100.00a	
	5	96.67ab	-3.33	73.33cde	-8.34	86.67c	-13.33
	7	80.00de	-20.00	73.33cde	-8.34	73.33d	-26.67
	9	76.87e	-23.33	73.33cde	-8.34	63.33e	-36.67
	11	73.33e	-26.67	66.66de	-16.68	63.33e	-36.67
Level of significance		*		*		**	
CV (%)		5.73		8.39		6.00	

Mean values within the column with similar letter(s) are not significantly different whereas dissimilar letter(s) are statistically different; LS = Level of significance, CV = Co-efficient of variation, \* = Significant at 5% level of probability, \*\* = Significant at 1% level of probability

**3.2 Seedling growth parameters**

The outcomes of the current study presented highly significant variation in seedling growth characters due to the influence of different mungbean varieties (Table 3). The highest root length (5.43 cm), shoot length (7.17 cm), and seedling vigor (1236.0) was witnessed in BARI Mung-6 whereas the lowermost root and shoot length were found in BARI Mung-8 (4.38 cm

and 6.26 cm, respectively). Moreover, BARI Mung-6 exhibited the maximum seedling vigor. The seedling vigor index of BARI Mung-7 (1022.80) and BARI Mung-8 (1038.00) be there noticed statistically similar. It has been described that the ability to withstand low osmotic potential is necessary for seedling survival in saline soils (Roundy, 1985).

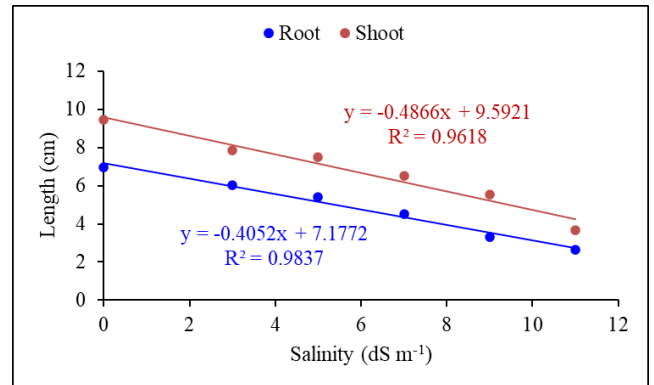
Variety	Root length (cm)	Shoot length (cm)	Seedling vigor index
BARI Mung-6	5.43a	7.17a	1236.00a
BARI Mung-7	4.62b	6.83b	1022.80b
BARI Mung-8	4.38c	6.26c	1038.00b
Level of significance	**	**	**
CV (%)	4.66	3.94	8.39

Mean values within the column with similar letter(s) are not significantly different whereas dissimilar letter(s) are statistically different; LS = Level of significance, CV = Co-efficient of variation, \* = Significant at 5% level of probability, \*\* = Significant at 1% level of probability

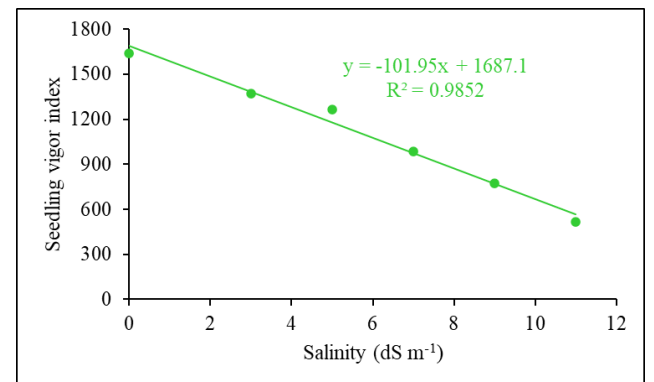
Seedling growth parameters of mungbean varieties varied significantly when various water salinity was applied. The highest root length (6.95 cm), shoot length (9.45 cm), and seedling vigor (1640.0) were resulted in the control treatment (0 ds m<sup>-1</sup>) whereas the lowest one was found in 11 ds m<sup>-1</sup> (2.65 cm, 3.68 cm and 514.90) (Fig. 2 and Fig. 3). Because of low intracellular water potential and water deficit surrounding the rhizosphere brought on by salt stress, roots were unable to acquire enough water and mineral elements for healthy plant progress (Sunil et al., 2012).

Both root and shoot lengths when plotted against different salinity levels linear but negative relationships were obtained implying that all the root length and shoot length diminished progressively with growing salinity levels (Fig. 2). The regression equations found were:  $y = -0.4052x + 7.1772$ ,  $R^2 = 0.9837$  (for root length);  $y = -0.4866x + 9.5921$  and  $R^2 = 0.9618$  (for shoot length). The regression equations also suggests that reduction is the minimum for root length but the maximum for shoot length. And more than 95% ( $R^2 = 0.9837$  and  $R^2 = 0.9618$ ) of the variations in root and shoot

length could be described by the variation in salinity levels as exposed by the two regression equations. The seedling vigor index also exhibited a negative and linear relationship with salinity ( $y = -101.95x + 1687.1$  and  $R^2 = 0.9852$ ) (Fig. 3) where about 98% in the variation of seedling vigor index might be defined by various salinity levels too.



**Figure 2:** Functional relationship between salinity and root and shoot length in three mungbean varieties



**Figure 3:** Functional relationship between salinity and seedling vigor index in three mungbean varieties

Variety	Salinity (ds m <sup>-1</sup> )	Root length (cm)	Variation over control (%)	Shoot length (cm)	Variation over control (%)	Seedling vigor index	Variation over control (%)
BARI Mung-6	0	8.50a		8.93b		1743.30a	
	3	8.20a	-3.53	8.43cd	-5.60	1663.00b	-4.61
	5	6.95b	-18.24	8.00d	-10.42	1495.30c	-14.23
	7	5.10f	-40.00	7.51e	-16.02	1219.30ef	-30.03
	9	4.10g	-51.73	6.06fg	-32.14	982.17g	-43.63
	11	3.50h	-58.83	4.00j	-55.21	677.30i	-61.15
BARI Mung-7	0	6.20b		8.86bc		1506.00c	
	3	6.00bcd	-3.23	7.53e	-14.73	1307.95cde	-13.16
	5	5.70de	-8.07	7.16e	-19.19	1245.00def	-17.33
	7	4.20g	-32.26	5.66gh	-33.12	880.40gh	-41.67
	9	3.20h	-48.39	5.03i	-43.68	715.30i	-52.52
	11	2.30i	-66.91	3.33k	-62.71	433.30j	-71.22
BARI Mung-8	0	6.30b		10.56a		1686.00a	
	3	6.10bc	-3.18	8.83bc	-16.39	1493.30c	-11.43
	5	5.10f	-19.05	7.23e	-31.54	1193.30f	-29.33
	7	4.10g	-34.93	6.36f	-39.78	840.70h	-50.17
	9	2.50i	-60.32	5.56h	-47.35	619.70i	-63.27
	11	2.10i	-66.67	3.73jk	-64.38	435.30j	-74.16
Level of significance		**		**		**	
CV (%)		4.66		5.73		8.39	

Mean values within the column with similar letter(s) are not significantly different whereas dissimilar letter(s) are statistically different; LS = Level of significance, CV = Co-efficient of variation, \* = Significant at 5% level of probability, \*\* = Significant at 1% level of probability.

The collective effect of mungbean varieties and salinity points considerably acted on seedling growth characters of mungbean (Table 4). In various combinations, BARI Mung-6 produced the longest roots (8.50 cm) when grown under control condition which was statistically similar to root length of BARI Mung-6 with 3 dS m<sup>-1</sup> salinity. The minimum root size was recorded in BARI Mung-8 (2.10 cm) at 11 dS m<sup>-1</sup> salinity. The longest shoot (10.56 cm) was obtained in BARI Mung-8 under control which was differed statistically from root lengths of other treatment combinations, whereas the shortest shoot (3.33 cm) was found in BARI Mung-8 under extreme salt stress i.e. 11 dS m<sup>-1</sup>. Salt application suggestively reduced the root and shoot lengths of the mungbean varieties but the magnitude of reduction were slightly higher in roots than in shoots (Table 4). The scale of reduction across varieties were 58.83, 66.91 and 66.57% in root length; 55.21, 62.71 and 64.38% in root length at 11 dS m<sup>-1</sup> as compared to control. The variety BARI Mung-6 showed the top seedling vigor index (1743.30) in absence of salt stress which is also statistically similar to seedling vigor index of BARI Mung-8 (1686.00) under the same condition. The poorest seedling vigor index was identified in BARI Mung-7 with 11 dS m<sup>-1</sup> (433.30).

Saline condition exerted noteworthy decrease in seedling growth characters which might be due mainly to decline in root and shoot lengths with significant innate variations. Growth restriction under salty situation might be due to the alteration of capital from growth to maintenance (Greenway and Gibbs, 2003). Salt stress resulted low intra-cellular water potential and water shortage round the root zone. Ultimately plant roots failed to absorb enough water and mineral elements for suitable plant progression (Sunil et al., 2012). Salinity blocked the assimilation of necessary minerals like P and K which might badly disturb seedling vigor (Nasim et al., 2008). Substantial fall in shoot and root length in the mungbean varieties might be owing to their variable reaction in terms of sensitivity to salt levels.

#### 4. CONCLUSION

The response of crop species to salt stress is a multidimensional phenomenon and based on the innate inconsistency of the plants in their response to salt pressure differed. From the current investigation, it was found that BARI Mung-6 was less affected by salinity and showed superior germination percentage, germination energy, germination capacity, root length, shoot length and seedling vigor followed by BARI Mung-7. Furthermore, all the germination and seedling growth parameters gradually decreased with increasing degree of salinity though the scale of reduction differed from variety to variety. It is worth noting that BARI Mung-6 performed well up to 7 dS m<sup>-1</sup> level (≤ 30% reduction compared to control, root length is the only exception). Therefore, BARI Mung-6 may be a useful resource for cultivation in the moderately saline soils of coastal Bangladesh.

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