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Effect of Seed Priming with Proline on Germination and Seedling Growth of Mungbean under Salt Stress

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ABSTRACT

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Key words:

Germination Mungbean, Proline, Salt stress, Seed priming

Seed priming is a pre-sowing treatment that enhances germination performance and stress tolerance of germinating seeds. The effect of seed priming with proline on germination and seedling growth of mungbean (*Vigna radiata* L.) under salt stress was investigated. The experiment carried out in completely randomized design with three replications in May 2018 at the Research Laboratory of the School of Agriculture and Rural Development, Bangladesh Open University, Gazipur, Bangladesh. Salt stress at 5 dSm^{-1} decreased seed germination percentage, plumule length, radicle length, plumule fresh weight, radicle fresh weight and seed vigour index compared to control. Seed priming with proline increased germination percentage (53.84%), plumule length, radicle length, plumule fresh weight, radicle fresh weight and seed vigour index under salt stress. The results suggested that seed priming with proline could effectively alleviate the inhibitory effects of salt stress on seed germination and seedling growth of mungbean.

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INTRODUCTION

Salinity is one of the major abiotic stresses that plants encounter. Globally, around 20% of the cultured land is affected by salinity (Billah et al., 2017). In Bangladesh, more than 30% of the cultivable area is in the coast. Out of it, 2.88 million hectares are affected by varying degrees of salinity (Karim et al., 1990). Mungbean (*Vigna radiata* L.) is an important pulse crop in South and Southeast Asia and is widely used due to its nutritional value. There are 30% protein, 65% carbohydrates and essential macronutrients like phosphorus 340 mg 100 g^{-1} and calcium 118 mg 100 g^{-1} in mungbean (Anwar et al., 2007).

Germination of seed can be influenced by many abiotic factors that restrict or inhibit it. Among these, salinity is one of the major abiotic stresses affecting seed germination, plant growth and reproduction (Zhu, 2002). Seed priming is widely used in the cultivation of plants to improve germination efficiency and field emergence under adverse environmental conditions (Carvalho et al., 2011; Jisha et al., 2013). Many studies have shown seed priming as a factor of increasing ribosomal RNA synthesis, produce more mitochondrial DNA (Bradford, 1986), increasing the activity of alpha and beta amylase (Powell, 1998), improving germination under salt stress. In addition, priming can change the amount of proteins, but their type remains unchanged (McDonald, 1999), improving Na^+/K^+ ratio (Theerakulpisut et al., 2016).

Proline is a proteinogenic amino acid which is extremely crucial for numerous important metabolic processes inside the plant tissues. Proline improve salt tolerance in plants and cultured cells via the maintenance of osmotic potentials, membrane integrity, enzyme activity and Na^+/K^+ ratio (Mansour, 1998; Okuma et al., 2000; Demiral and Türkan, 2004, Sobahan et al., 2009). It is suggested that proline is used as energy sources, and that proline may be metabolized as nitrogen source readily available for plant re-establishment just after the period of water limitation (KaviKishor et al., 2005; Trovato et al., 2008). The objective of the present study was to investigate whether seed priming with proline induce tolerance to salinity in seeds of mungbean.

MATERIALS AND METHODS

The experiment was conducted in the laboratory of the School of Agriculture and Rural Development, Bangladesh Open University, Gazipur in May, 2018. Mungbean variety namely BARI mung-6 was collected from Bangladesh Agricultural Research Instiitute (BARI), Gazipur. Seeds were surface sterilized with 0.1% (w/v) Sodium hypo chloride and washed thoroughly with distilled water at room temperature. These surface sterilized seeds were primed in proline at 5 mM (Singh et al., 2018) for 6 hours. Unprimed seeds served as control. After incubation into primed solution seeds were air dried at room temperature. The experiment was conducted in completely randomized design (CRD) with three replications. Three replicates of 10 seeds were transferred to filter paper containing petri dish. Ten ml of NaCl solution (5dSm^{-1}) (Singh et al., 2018) was added in respective petri dishes. The control contained 10 ml of distilled water. After three days seedlings were removed from the petridishes and germination percentage, plumule length (cm), radicle length (cm), plumule fresh weight (gm), radicle fresh weight (gm) and seed vigour index were measured.

Germination percentage (%) was calculated using the following formula (Scotte et al., 1984):

$$\text{Germination (\%)} = \frac{\text{Total number of germinated seeds}}{\text{Total seed placed for germination}} \text{ x } 100$$

Vigour index was calculated using following formula (Abdul-Baki and Anderson, 1970):

$$\text{Vigour index} = \frac{\text{Germination (\%) X Seedling length (cm)}}{100}$$

Statistical analysis

The treatment means were compared using Duncan's new multiple range tests using MSTAT-C program. Differences at $p < 0.05$ were considered as significantly different.

RESUTLS AND DISCUSSION

Germination is the most critical stage in the life cycles of plants (Ahmad et al., 2009) that determines the crop production. In this study, salt stress decreased mungbean germination compared to unprimed seed (control). Germination increased after priming with proline under salt stress condition (Fig. 1). Figure 2 shows that salt stress significantly decreased (40.91%) seed germination percentage compared to control. Germination percentage significantly increased (53.84%) after priming with proline under salt stress condition. Zekri (1993) reported that salinity adversely affects seed germination by decreasing the osmotic potential of the soil solution to prevent the intake of water. Kaur et al. (2015) found that proline has an important role in increasing germination and it also increases resistance to various stresses.

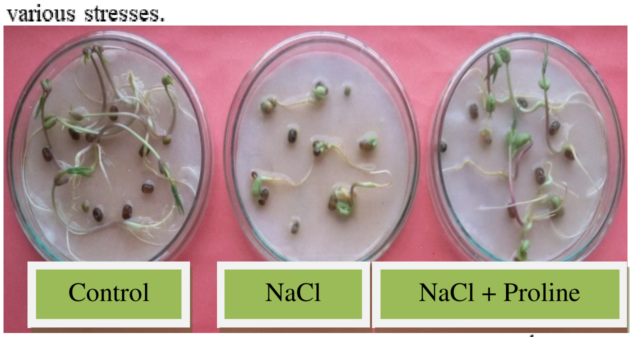

Figure 1. Mungbean germination treated with 5dSm^{-1} NaCl in the presence and the absence of 5 mM proline.

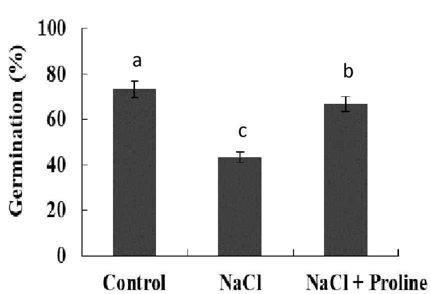

Figure 2. The effect of seed priming with proline (5mM) on germination (%) of mungbean under salt stress (5dSm^{-1}) condition. Error bars represent standard deviation. Bars with different letters are significantly different at $p < 0.05$.

Salinity stress adversely affects the plant growth and development (Das and Panda, 2001). Result of this study showed that salt stress significantly decreased plumule length as well as radicle length of mungbean. Priming with proline significantly increased plumule length (56.68%) and radicle length (27.55%) under salt stress condition (Figs. 3A and B). Lin and Kao (1996) reported that NaCl was effective in inhibiting root growth and in increasing proline accumulation in roots that preceded inhibition of root growth caused by NaCl.

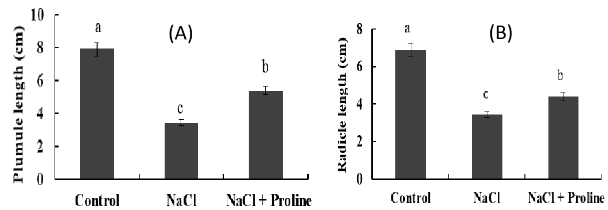

Figure 3. The effect of seed priming with proline (5 mM) on Plumule length (A) and Radicle length (B) of mungbean under salt stress (5dSm^{-1}) condition. Error bars represent standard deviation. Bars with different letters are significantly different at $p \leq 0.05$.

In this study, salt stress significantly decreased plumule and radicle fresh weight. Cicek and Cakirlar (2002) mentioned that salinity stress restricts the ability of plant cells to take up water and reduces plant growth. Seed priming with proline significantly increased plumule fresh weight (55.65%) and radicle fresh weight (38.24%) under salt stress condition (Figs. 4A and B). Similar result was found by Deivanai et al. (2011) that pre-treatment of proline was found to be effective in improving plant growth under salt stress condition. It has been shown that proline would have been absorbed by the developing seedlings, where it maintained water status by increasing water influx and reducing the efflux of water under salt-induced water-limiting conditions (Chen and Murata, 2008). It is suggested that proline protects cell membranes against ion toxicity and salt-induced oxidative stress, increased cellular growth (Banu et al., 2009), and thus increased the growth of mungbean seedlings.

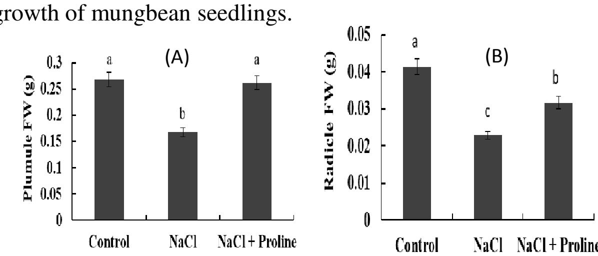

Figure 4. The effect of seed priming with proline (5mM) on plumule (A) and radical (B) fresh weight (FW) of mungbean under salt stress (5dSm^{-1}) condition. Error bars represent standard deviation. Bars with different letters are significantly different at $p \leq 0.05$.

Seed vigour index is related to the special impact of ions and reduction of water potential under salt stress (Bijeh Keshavarzi et al., 2011). The data of seed vigour index of mugbean is presented in Figure 5 which showed that maximum seed vigour index was noticed in control condition. Salinity stress significantly reduced the seed vigour index. Similar result was found by Shahri et al. (2012) who reported that vigour index decreased when salt concentration increased. Priming with proline significantly improved the seed vigour index of mugbean grown under salt stress. This result is consistant with Singh et al. (2018) who suggested that the proline with seed priming is an effective technique that increases seed vigour index in rice seedlings.

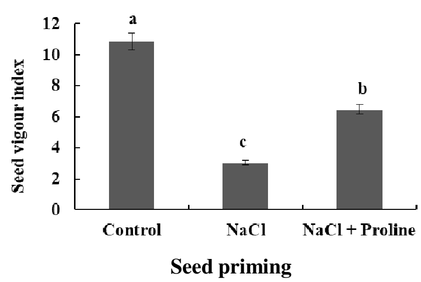

Figure 5. The effect of seed priming with proline (5mM) on seed vigour index of mungbean under salt stress ($5dSm^{-1}$) condition. Error bars represent standard deviation. Bars with different letters are significantly different at $p \leq 0.05$.

CONCLUSION

Salt stress decreased germination and seedling growth of mungbean. Seed priming with proline could effectively alleviate the inhibitory effects of salt stress on seed germination and seedling growth of mungbean. Seed priming with proline can effectively be used in mungbean cultivation in saline soils.

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