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RESEARCH ARTICLE

Effect of salinity on germination and seedling growth of green gram varieties

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SUMMARY

Salinity tolerance is one of the important abiotic stresses that damages crop growth. In order to study the effect of saline on germination and seedling attributes, four cultivated varieties of greengram were subjected with five levels of salinity *viz.*, 0, 4, 8 and 12 ds/m. Genotypic variation was observed for germination and seedling characters among the varieties. The experimental results revealed that with increase in salinity levels, greater reduction was observed for all the parameters. Germination per cent, seedling length, shoot, root and total dry matter production, seed vigour and salt tolerance index were found reduced in all the varieties studied with more reduction at higher salinity (12 ds/m) level rather than other lower salinity levels and shoot root ratio was found increased with increase in salinity.

Key Words : Green gram, Salinity, Germination, Seedling characters

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Abiotic stresses affect the physiological status of any living organism and adversely affect the agricultural productivity (Bartels and Sunkar, 2005). Among the abiotic stresses, salinity is one of the major abiotic stress affecting crop growth and productivity. Salt stress is reported as a serious problem (Nedjimi and Daoud, 2006). Salinity stress adversely affects agricultural yield throughout the world whether it is for subsistence or economic gain (Goumi *et al.*, 2011). The crop plant must be capable of producing satisfactory biomass production in a saline environment (Yokoi *et al.*, 2002). Such selective crops alone can be cultivated under these saline conditions.

Seed germination and seedling growth are major factors deciding the establishment of crops under saline conditions (Kitajima and Fenner, 2000). Salinity may cause significant reductions in germination leading to reduced crop yields. Salt tolerance at germination stage is important factor. High concentration of salts have detrimental effects on germination of seeds (Sharma *et al*., 2004 and Saboora and Kiarostami, 2006). Legumes account for around 27 per cent of the world's crop production (Graham and Vance, 2003). Among the different legumes, mungbean or greengram [*Vigna radiate* (L.)] is an important pulse crop cultivated in many parts of the country. Since the extent of inland salinity is increasing gradually in coastal areas the response of green gram varieties to such coastal salinity has to be well studied. Hence, in the present study, effect of salt stress on germination and seedling growth of four green gram varieties was carried out with the objective of identifying the physiological and morphological response

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of those varieties to salt stress tolerance.

MATERIAL AND METHODS

To begin with, NaCl solutions were prepared by dissolving required quantity of sodium chloride in distilled water to get four different concentrations (0, 4, 8 and 12 ds/m) and left for 48 h in order for complete dissolution. After the solution preparation, petri dishes were washed and disinfected with alcohol and air dried. Healthy and uniform seeds of four green gram varieties *viz*., VBN 2, VBN 3, ADT 3 and CO 8, were surface sterilized and washed with distilled water. Then the seeds were placed in sterile petri dishes (9 cm diameter) lined with two sterile What man number 1 filter paper with 5ml of distilled water for control and the respective test solutions for inducing salt stress. Ten seeds per petridish were takrn and the experiment was conducted in Completely Randomized Design (CRD) with three replications.

Germination test was conducted under condition of 12 h light/dark cycle with 14^0C minimum and 24^0C maximum temperature. A seed was considered as germinated when its radicle was about 2mm long. The germination percentage was determined by counting the number of geminated seeds. After final count, germination percentage (GP) was calculated by using the following formula (Raun *et al*., 2002).

$$GP = \frac{\text{Number of total germinated seeds}}{\text{Total number of seeds tested}} \text{x } 100$$

The shoot and root length and seedling dry weight was taken on the 15^{th} day. The length from the collar region to tip of the primary root and to tip of the primary shoot were measured and expressed in centimetre for root and shoot length, respectively.

The shoots and root were separated, oven dried at 60^0C for 24 hours and dry weights were recorded. Vigour index I and vigour index II were calculated by multiplying germination per cent and seedling length and germination per cent and dry matter production, respectively. Shoot root ratio was worked out by dividing dry weight of shoot by dry weight of root. Salt tolerance index (STI) was calculated by using dry weight with the following formula:

$$STI = \frac{\text{Total DW salt stress}}{\text{Total DW control}} \text{x } 100$$

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads and Figs. 1 to 8.

Effect on germination percentage :

It was found that with increase in salinity, there was decrease in germination percentage in all the cultivars studied and genotypic differences were observed among the cultivars in respect of saline tolerance. Eventhough increased salt concentration decreased germination percentage, more reduction was observed under high salt stress rather than under low salt stress (Berhanu and Berhane, 2014).

Among the varieties tested, VBN 3 performed better followed by CO 8, VBN 2 and ADT 3. At higher salinity level of 12 ds/m, VBN 3 recorded germination per cent of 69.21. The lowest germination per cent was recorded in ADT 3 at 12 ds/m (39.32). Salinity stress caused greater reduction in germination per cent in all the varieties tested at all salinity levels.

Babbar and Dhingra (2007) reported decrease in seed germination and seedling growth rate with increasing levels of salinity in mung bean varieties. In addition to toxic effects of certain ions, higher concentration of salts reduce water potential in the medium which in turn hinders water absorption by germinating seeds and resulting in reduction in germination (Hakim *et al*., 2010). Variability in salinity tolerance among rice varieties at germination have also been reported by Mondal *et al*. (1988) and Hakim *et al*. (2010). Different salinity levels did not affect the germination percentage of varieties tested and at all the salinity levels, varieties LBG-22, LBG-402 and LBG-738 recorded lesser mortality values when compared to other varieties (Shanti *et al*., 2014). Seeds in the control (0 mM NaCl) had the highest germination percentage (100%) and with increase in salt concentration, germination percentage decreased upto 250 mM NaCl concentration (Carpici *et al*., 2009).

Effect on seedling length :

Seedling length was found reduced with proportionate increase in salinity stress and maximum reduction in seedling length was observed in 8 ds/m stress in all the varieties studied. Shoot and root length are important criteria in studying the response of plants to salt stress (Jamil and Rha, 2004). Both the shoot and root length of the seedlings grown in different salinity levels showed decreasing trend, indicating that the salts stress not only affected germination but also the growth of seedlings. This is in conformity with the findings of

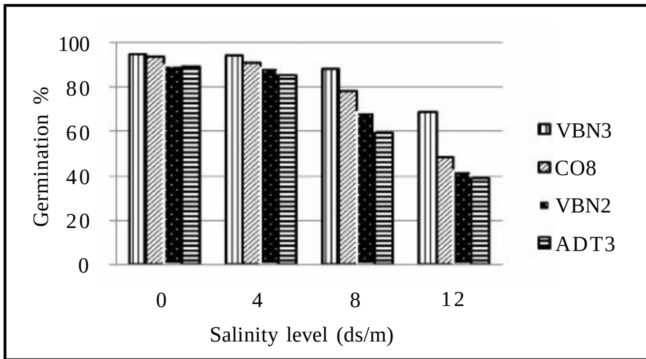

Fig. 1 : Effect of salinity on germination %

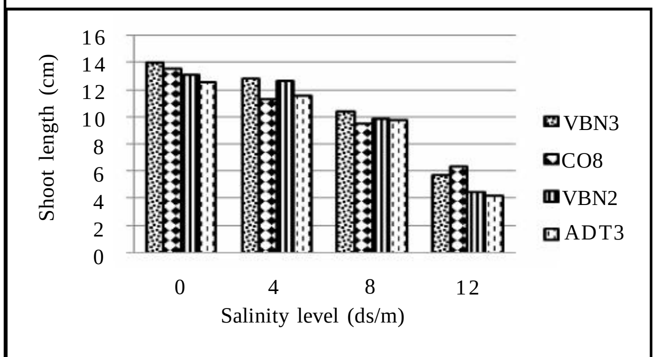

Fig. 2 : Effect of salinity on shoot length (cm)

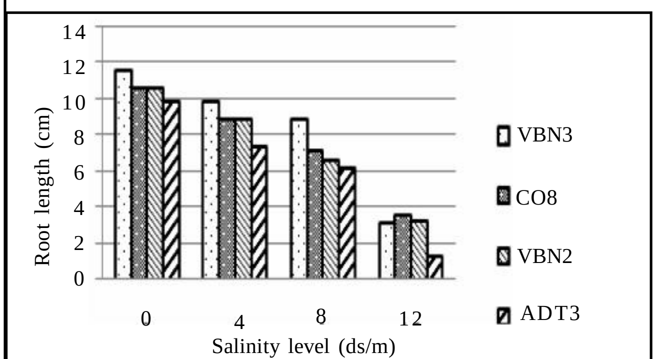

Fig. 3 : Effect of salinity on root length (cm)

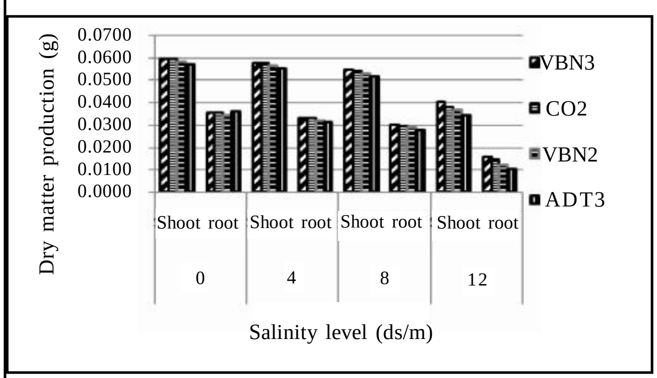

Fig. 4 : Effect of salinity on dry matter production (g)

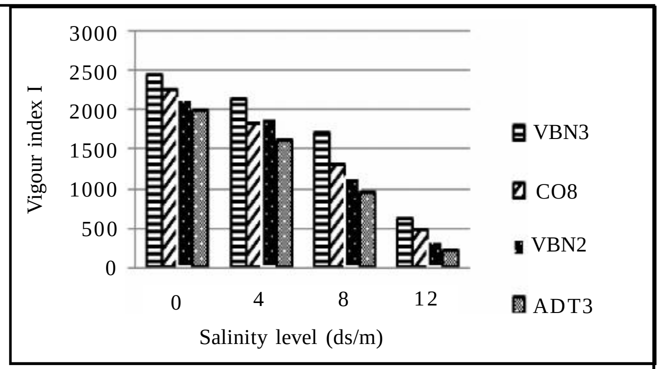

Fig. 5 : Effect of salinity on vigour index I

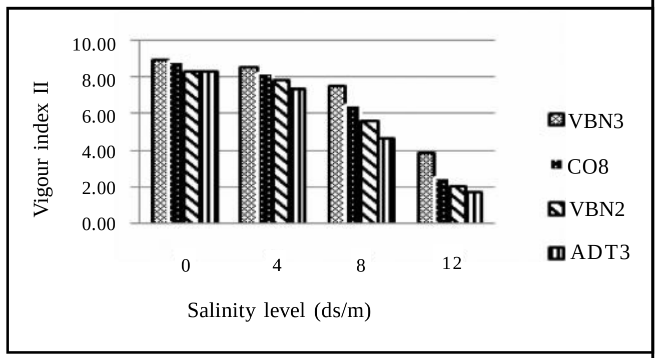

Fig. 6 : Effect of salinity on vigour index II

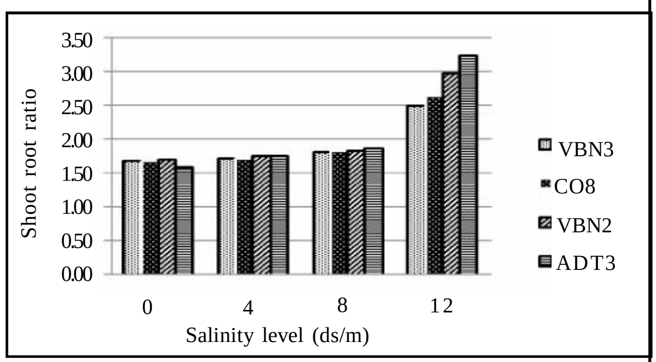

Fig. 7 : Effect of salinity on shoot root ratio

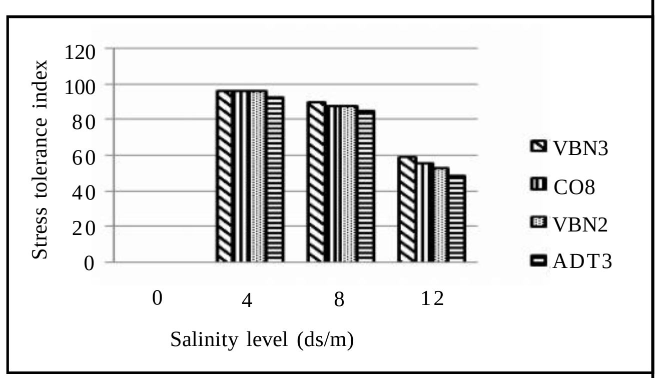

Fig. 8 : Effect of salinity on stress tolerance index

Fig. 1-8 : Effect of salinity on various seedlings attributes of green gram

Djanaguiraman *et al*. (2003) and Hakin *et al*. (2010). Reduction in seedling growth as a result of salt stress has been reported by Achakzai *et al*. (2010) and Akram *et al*. (2010) in several other crops.

In case of seedling length also, VBN 3 recorded higher shoot length and root length at 4 and 8 ds/m except at 12 ds/m. At 12 ds/m CO 8 registered higher shoot and root length. It was observed that ADT 3 recorded lowest shoot length and root length of 4.26 and 1.24 cm, respectively at 12 ds/m level. It was noted that root length was more decteased when compared to shoot length at all salinity levels. It has been reported that when compared with shoot, root elongation is more sensitive in salt stress and roots are also injured more severely because they are the first organs to face the stress (Berhanu and Berhane, 2014).

Effect on dry matter production :

In was found that shoot and root dry matter was decreased at all the salinity levels. Under normal salt-free condition, VBN 3 and CO 8 recorded higher dry matter of 0.0943 g seedling^{-1} followed by ADT 3 and VBN 2. At higher salinity of 12 ds/m, VBN 3, CO 8 and VBN 2 recorded lower dry matter with the least of 0.0450 g seedling^{-1} produced by ADT 3. The shoot dry weights of cultivars were negatively affected with increasing salt treatments and root dry weight of cultivars decreased significantly as the levels of salinity increased from 0 to 250 mM NaCl (Carpici *et al*., 2009). The present findings are in agreement with the results obtained by Mohammadi *et al*. (2008); Pessarakli and Kopec (2009) and Berhanu and Berhane (2014).

Hussein *et al.* (2007) reported negative relationship between vegetative growth parameters and increasing salinity. Akram *et al*. (2007) found that root dry weight of all corn hybrids showed a decline towards increase in salinity level. The growth of bengal gram was also severely affected by irrigation with 6 and 8 EC (ds/m) when compared to best available water (Neera and Ranju, 2004).

Effect on seed vigour :

There was decline in seed vigour index with increase in salt concentrations. Among the varieties, VBN 3 recorded higher vigour index I and vigour index II of 2444.04 and 8.98 at control and the lowest vigour index I and II was recorded by ADT 3 which has registered 2002.99 and 8.30, respectively. At the highest salinity level of 12 ds/m also, VBN 3 recorded higher vigour index I and II and the lowest was recorded by ADT 3.

Salinity suppresses uptake of essential nutrients like P and K (Nasim *et al*., 2008), which could adversely affect seedling growth and vigour. During salt stress, there is decrease in water uptake during both imbibition and seedling establishment and this can be followed by uptake of ions, resulting in physiological and biochemical changes in seeds and seedlings (Prisco *et al*., 1981 and Gomes and Sodek, 1988). Sathiyanarayanan *et al.* (2014) reported that seeds fortified with $MgSO_4$ + polykote + carbendazim + dimethoate + bioinoculant (*Pseudomononas fluorescens*) + *Rhizobium* + Azophos + pelleting with DAP recorded higher seed quality parameters like germination percentage, root length, shoot length, dry matter production and vigour index than the control under salt stress condition.

Effect on shoot root ratio :

It was found that, shoot root ratio increased with increase in salinity which shows the adaptation of roots to absorb more water under stress conditions. In the present study, highest shoot root ratio was observed in ADT 3 at 12 ds/m whereas in control VBN 2 recorded higher shoot root ratio. Nisachon *et al*. (2012) reported that drought significantly reduced stalk diameter, biomass, root length, root surface area, root volume and root dry weight, but it did not significantly affect root/shoot ratio, WUE and RHG. Benjamin *et al*. (2014) observed increased root shoot ratio as water deficit stress increased at all growth stages in corn because proportional decrease of shoot biomass was greater than the proportional decrease in root biomass.

Effect on salt tolerance index :

Decrease in salt tolerance index was observed with increase in salinity levels. The salt tolerance index of cultivars at the early seedling stage showed large genotypic variation. Carpici *et al*. (2009) also reported the same. Among the varieties studied, VBN 3 recorded higher salt tolerance Index followed by other varieties at all the salinity levels. Injury rate increased with increasing concentration of salinity level (Berhanu and Berhane, 2014). Similar observations were made by Hadush and Gebreslassie (2012) on *L. sativus* landraces.

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