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EFFECT OF SALINITY ON GERMINATION AND EARLY VEGETATIVE GROWTH OF COWPEA

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ABATRACT

Khan MSI, Khan ZUM, Khanam D (2012) Effect of salinity on germination and early vegetative growth of cowpea. *Int. J. Sustain. Crop Prod.* 7(3), 8-12.

The study was conducted in a laboratory at room temperature at Regional Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Rahmatpur, Barisal during 2006. Nine levels of NaCl concentrations were imposed on Cowpea (*Vigna unguiculata*) seeds to evaluate the germination and seedling vigor. The NaCl concentrations were equivalent to EC of 0.75 (control), 2, 4, 6, 8, 10, 12, 14 and 16 dS/m. The study was carried out in a completely randomized design (CRD) with 4 replications. Germination and early growth of cowpea seed and seedling seriously hampered with higher salinity levels. More than 50% seed failed to germinate at 10 dS/m salinity and this salinity level may be considered as 50% lethal dose (LD_{50}) for cowpea seed germination. Root and shoot length reduction increased and seedling vigor decreased with increased level of salinity. About 50% reductions of root and shoot length of cowpea occurred at 8 dS/m and it reached more than 80% at 10 dS/m salinity. Almost 100% root and shoot length reduction was observed at 12 dS/m and upward salinity.

Key words: *cowpea, germination, salinity, EC*

INTRODUCTION

Cowpea is one of the major legume crops in coastal areas of Bangladesh and salt stress is one of the main factors limiting its productivity. Cowpea is inherently more drought and salinity tolerant than other crops but it still suffers considerable damage due to frequent drought and salinity stresses in different regions where rainfall is scanty and irregular. In saline environment adaptation of plants to salinity during germination and early seedling stage is crucial for establishment of the species. Salinity affects germination of seeds either by creating osmotic potential, which prevent water uptake, or by toxic effects of ions on embryo viability (Lianes *et al.* 2005). Salt stress usually affects many physiological aspects of plant growth. Shoot growth and dry matter are reduced by salinity, root:shoot ratio is increased (Rahman *et al.* 2008). It was also proven that salinity tolerance during germination stage is critical for field emergence and early seedling vigor of cowpea. The most worldwide spread method for determination of plant tolerance to salts is the germination percentage in salt solutions. As well as germination tests and vigor tests are useful to evaluate the seeds physiological quality during salt stress. These evaluations are important to estimate the performance potential of the seeds at the field in salt stressing environments. Therefore, this study has been designed to evaluate the sensitivity to salinity of cowpea during germination and early seedling stage under laboratory condition, before testing under actual field situations.

MATERIALS AND METHODS

The study was conducted in a laboratory at room temperature at Regional Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Rahmatpur, Barisal during 2006. Nine levels of NaCl concentrations were imposed on Cowpea (*Vigna unguiculata*) seeds to evaluate the germination and seedling vigor. The NaCl concentrations were equivalent to EC of 0.75 (control), 2, 4, 6, 8, 10, 12, 14 and 16 dS/m. The salinity levels were designated as T_1 through T_9, respectively. The study was carried out in a completely randomized design (CRD) with 4 replications. Seeds were sterilized with 0.1% $HgCl_2$ for 2-3 minutes and rinsed thoroughly with distilled water. Twenty healthy cowpea seeds were placed on Whatman No. 1 filter paper in a glass petri dish. The filter papers were moistened with respective NaCl solution for each treatment. Ten ml of NaCl solution for respective treatments were applied on alternate days to each petri dish. Germinated seeds were counted daily. According to ISTA (1999) protocols germination percentage, radicle length, hypocotyl length, numbers of secondary roots were recorded daily up to seven days after sowing and seed vigor index (SVI) parameters were calculated following the formula suggested by Mugnisjah and Nakamura (1984).

$$\textbf{Germination (\%)} = \frac{\text{Total number of germinated seeds in a petri dish}}{\text{Total number of seeds placed in a petri dish}} \times 100$$

Germination capacity (GC) = (100/n) G_3

Where n is number of germinated seeds and G_3 is number of seedlings with more than 2 cm radicle length at three days after germination.

Seedling vigor index (SVI) was calculated following modified formula of Abdul-Baki and Anderson (1973).

Seedling vigor index (SVI) = Germination (%) x Radicle length (cm) + Number of secondary roots.

Shoot length (cm): Shoot length was measured from the root base to the tip of the shoot at 7 days after sowing.

Root length (cm): Root length was measured from the root base to the tip of the root at 7 days after sowing.

$$\textbf{Reduction of shoot length (\%)} = \frac{\text{Shoot length at non- saline – shoot length at saline}}{\text{Shoot length at non- saline condition}} \times 100$$

$$\textbf{Reduction of shoot length (\%)} = \frac{\text{Root length at non- saline – root length at saline}}{\text{Root length at non- saline condition}} \times 100$$

Root/shoot ratio = Root length / Soot length

The experimental data were analyzed statistically and the treatment means were compared by using DMRT at 1% level of probability following Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Results on germination and seedling growth parameters i.e. Hypocotyle length, Radicle length, Secondary root, Root/shoot ratio as influenced by salinity are presented in Table 1.

Germination percentage

Germination was greatly reduced with increasing salt concentration. The highest germination (99%) was recorded at control treatment (0.75 dS/m) that was similar with T_2 (2 dS/m) and T_3 (4 dS/m) and the lowest (22%) at 16 dS/m salinity. It was also found that >52% germination remained up to 10 dS/m salinity. In 12 dS/m salinity germination reduced >50%. So, 10 dS/m salinity level was considered as 50% lethal dose (LD_{50}) for cowpea and was used a demarcation level between tolerance and susceptibility. Reduction of germination may be due to osmotic stress or ionic toxicity created by increased submersion times and NaCl concentrations. The results are in agreement with West and Francois (1982), Basalah (1991), Huang and Redman (1995) and Murollo-Amador and Troyo-Dieguez (2000).

Table 1. Salinity sensitive characteristics of cowpea as affected by different levels of NaCl concentration

Salinity	Germination (%)	Germin^n capacity	Radicle length (cm)	Hypocotyle length (cm)	Secondary root (No.)	Root/shoot ratio
T_1 (control)	99 a	99.67 a	12.5 a	20.50 a	41.67 a	0.61c
T_2 (2 dS/m)	98 a	99.33 a	12.1 a	19.27 b	39.00 a	0.63 c
T_3 (4 dS/m)	94 a	95.33 a	7.8 b	16.63 c	28.00 b	0.47 c
T_4 (6 dS/m)	76 b	75.33 b	7.3 b	13.90 d	23.67 c	0.53 c
T_5 (8 dS/m)	64 c	63.67 c	5.8 c	5.43 e	14.67 d	0.93 b
T_6 (10 dS/m)	52 d	58.00 c	2.9 d	2.90 f	13.00 d	1.0 b
T_7 (12 dS/m)	45 e	43.33 d	2.1 e	1.57 g	5.33 e	1.4 a
T_8 (14 dS/m)	31 f	13.33 c	1.43 ef	0 h	0 f	0 d
T_9 (16 dS/m)	22 g	5.00 f	1.20 f	0 h	0 f	0 d
CV (%)	4.22	4.43	3.92	4.59	3.45	5.43
Sig. $_{(.01)}$	**	**	**	**	**	**

Germination capacity

Germination capacity of cowpea seed decreased with increasing level of salinity (Table 1). Variation was found in germination capacity among the treatments. In the control, 2 dS/m and 4 dS/m salinity germination capacity was found similar and higher then other treatments. Germination capacity decreased at higher rate of salinity. This might have occurred due to a possible priming effect caused by NaCl concentration. Priming can improve seed performance, due to its effect in repairing damaged membranes and organelles, resulting in a faster seed emergence and higher seedling growth (McDonald 1998).

Hypocotyle length

Highly significant differences were found in hypocotyle length of cowpea at different levels of salinity. The highest hypocotyls length (20.50cm) was found in control and the lowest (1.57cm) in 12-dS/m salinity but reduced at a higher rate in 8 dS/m and upward. Cowpea seeds were unable to produced shoot at 14 dS/m and upward salinity. Dantas *et al.* 2005, reported similar results. They showed that when cowpea seeds were placed to 10.2 dS/m NaCl solution, the hypocotyl length decreased 55.6% to 70.3%.

Radicle length

A remarkable difference was also found in radicle length of cowpea seedling in different levels of salinity. The results indicate that root length decreased significantly with the increase of salinity level. The result is in agreement with the findings of Murillo-Amador & Troyo-Diéguez (2000). They stated that salinity inhibits cowpea shoot and root growth drastically at EC higher than 7.8 dS/m. Similar findings were also stated by Nag (2005), who reported significant reduction of root length of mustard and rapeseed caused by increasing salinity level.

Secondary root

Initiation of secondary root was affected adversely due to salinity. Higher salinity levels were found detrimental to the growth of secondary roots. The number of secondary roots of cowpea varied between 42 in control and 5 in 12 dS/m salinity. It means higher salinity reduces root surface area in rhizosphere.

Root-shoot ratio

Root-shoot ratio indicates the root and shoot growth pattern of a crop. The high root shoot ratio means the higher root growth while the lower ratio means the higher shoot growth. Root shoot ratio of cowpea was the highest in 12 dS/m (1.4) fallowed by 10 dS/m (1.0) and 8 dS/m salinity (0.93). In higher salinity level, root shoot ratio was the highest. It means root and shoot growth was seriously inhibited by higher concentration of NaCl solution.

Root and shoot reduction

Root and shoot length reduction was increased with increased level of salinity (Photograph 1 and Fig 1). More than 50% reduction of root and shoot length of cowpea were occurred in 8 dS/m and it reached >80% in 10 dS/m salinity. Almost 100% reduction of root and shoot were observed in 12 dS/m and root and shoot development was strictly inhibited by salinity >12 dS/m.

Photograph 1. Shoot and root growth of cowpea seedling in different salinity level

Seed vigor index (SVI)

SVI decreased with increasing salinity, ranging between 788 in control and 20 in T_9 (16 dS/m). SVI reduced drastically in 10 dS/m and upward salinity (Fig 1 and Photograph 2).

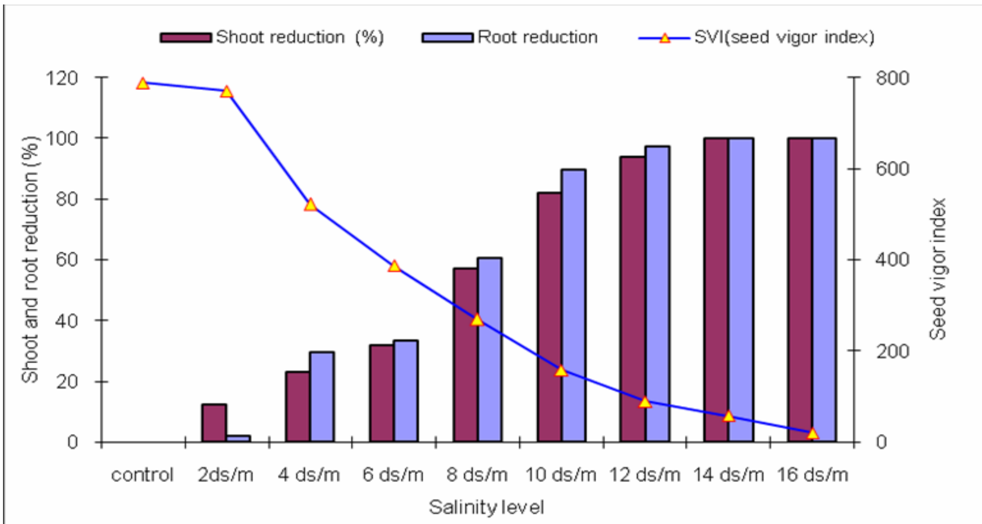
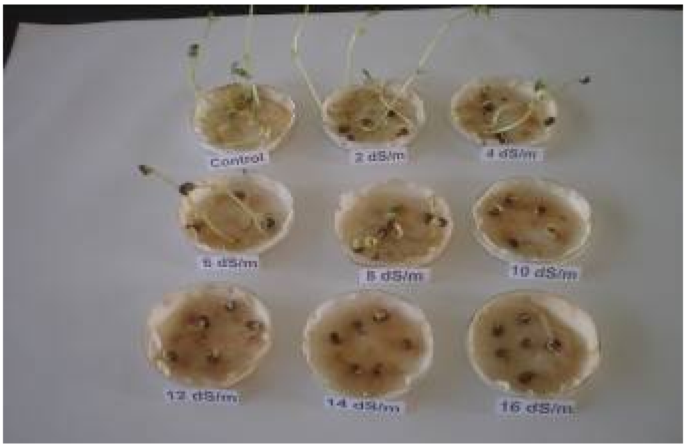


Fig: 1 Seedling vigor as affected br different levels of salinity



Photograph 2. Vigority of cowpea seedlings in different salinity levels

Plant biomass

Fresh and dry weight of root and shoot showed a gradual decrease with the increasing salinity levels (Table 2). At 4 dS/m NaCl salinity the fresh and dry weight of root decreased to 10% and 9% respectively of the control, whereas at 12 dS/m fresh weight decreased to 79% and dry weight decreased to 83% of the control. In case of shoot, fresh weight decreased 8% and dry weight decreased to 4% of the control at 4 dS/m NaCl salinity, whereas at 12 dS/m fresh and dry weight of shoot decreased to 91% and 83% of the control respectively. There was a trend to decrease fresh and dry weight of shoot and root with the increasing salinity level. The increased fresh and dry weight of root and shoot could be possible upto salinity level 8 dS/m and then decreased sharply and no weight was recorded beyond 12 dS/m. Garg and Gupta (1998) observed that salinity significantly reduced dry matter accumulation in both roots and shoots in chickpea.

Table 2. Effect of salinity on fresh and dry weight of roots and shoots of cowpea

Salinity	Fresh weight of shoot plant^{-1} (mg)	Dry weight of shoot plant^{-1} (mg)	Fresh weight of root plant^{-1} (mg)	Dry weight of root plant^{-1} (mg)
T_1 (control)	648.33 a	73.23 a	89.00 a	20.10 a
T_2 (2 dS/m)	618.33 b	73.12 a	70.00 b	19.75 a
T_3 (4 dS/m)	595.00 c	70.05 a	80.00 b	18.25 b
T_4 (6 dS/m)	508.33 d	58.25 b	40.00 c	9.56 c
T_5 (8 dS/m)	453.33 e	59.33 b	38.00 c	10.1 c
T_6 (10 dS/m)	207.33 f	30.00 c	19.00 d	6.54 d
T_7 (12 dS/m)	58.00 g	5.00d	18.67 d	3.25 e
T_8 (14 dS/m)	0.00	0.00	0.00	0
T_9 (16 dS/m)	0.00	0.00	0.00	0
CV (%)	6.10	6.85	2.50	4.16
Sig. $_{(.01)}$	**	**	**	**

CONCLUSION

From the findings it may be concluded that cowpea seed germination decreased with increasing salinity and 10 dS/m salinity level may be considered as 50% lethal dose (LD_{50}). At early vegetative stage root and shoot growth of cowpea reduce drastically at 8 dS/m and onward salinity. Root and shoot growth completely seize at 12 dS/m and higher salinity.

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