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GERMINATION INDICES OF EGG PLANT (*SOLANUM MELONGENA* L.) UNDER SEA SALT SALINITY

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ABSTRACT

The experiment was performed to find the seed germination indices of eggplant under various salinity levels (0.1 to 1.0 % sea salt concentrations of EC_{iw} = 1.7 to 14.2 $dS.m^{-1}$). Distilled water was used as non-saline control (EC_{iw} = 0.5$dS.m^{-1}$). 100 % germination was recorded under non-saline control (0.5 $dS.m^{-1}$) at 7th day of the treatment. Significant decrease in germination percentage (GP%) and germination rate (GR) were proportionate to salinity. Decline in germination index (GI), and coefficient of velocity of germination (CVG) were noted with increasing concentration of sea salt 0.1% to 0.7% (EC_{iw} = 1.7 to 10.1 $dS.m^{-1}$ respectively) in irrigation water. Increased mean germination time (MGT) under increasing salinity regimes indicate the delaying of seed germination percentage. However, complete inhibition of seed germination was observed at 0.8% or above up to 1.0% sea salt salinity (EC_{iw} = 10.8 to 14.2 $dS.m^{-1}$) levels.

Key words: Germination percentages, germination rate, germination index, coefficient of velocity of germination, mean germination time, salinity, eggplant.

INTRODUCTION

The plants have developed various morphological, physiological, anatomical, biochemical even genetic changes under saline conditions (Hampson & Simpson, 1990; Munns and James, 2003; Ashraf, 2004; Tiwari *et al.*, 2010). Some plants are sensitive to salinity at germination stage, and some plants can tolerate at this stage and become sensitive at emergence and early seedling stages. Similar results were observed by Rahman *et al.*, (2001) in rice. Generally, greater seed germination has been observed under non-saline conditions and gradual loss of germination take place in increasing salinity levels of the medium. Shannon and Grieve (1999) reported that salinity at lower levels slows germination rate and at higher levels reduces germination percentage. Almansouri *et al.* (2001) reported increase in germination time in wheat under high sea salt salinity. Recently, Sarker *et al*. (2014) have reported loss of germination in radish, cabbage, mustard and water spinach in 8 and 16 $dS.m^{-1}$ treatments of salinity. Maiti *et al.* (2014) have studied comparative tolerance to salinity stress (NaCl) in a wide range of vegetables (okra, onion, sponge gourd, carrot, bitter gourd, bottle gourd, sweet corn, cucumber, water melon, tomato and chilli).

Eggplant is a common vegetable crop cultivated throughout the world. Unlukara *et al.*, (2010) have reported eggplant (*Solanum melongena)* as moderately sensitive to soil salinity with threshold value less than 1.5 dSm^{-1} and 4.4% slope for reduction of yield by unit increase in soil salinity. Present study was conducted to evaluate the germination indices of eggplant under increasing sea salt salinity.

MATERIAL AND METHODS

Seeds of eggplant were obtained from Five Star Agrochemicals, Karachi. Surface sterilized were soaked in distilled water and then placed 50 seeds on double layered filter paper in sterilized Petri plates (9 cm diameter). Moisten the filter paper with 10 ml of respective solutions Salinity treatments for this experiment were non saline control (distilled water) EC_{iw} = 0.5 $dS.m^{-1}$, 0.1 % = 1.7 $dS.m^{-1}$, 0.2 % = 2.8 $dS.m^{-1}$, 0.3 % = 4.2 $dS.m^{-1}$, 0.4 % = 5.4 $dS.m^{-1}$, 0.5 % = 6.9 $dS.m^{-1}$, 0.6 % = 8.6 dSm^{-1}, 0.7 % = 10.1 $dS.m^{-1}$, 0.8 % = 10.8 $dS.m^{-1}$, 0.9 % = 12.9 $dS.m^{-1}$, 1.0 % = 14.2 dSm^{-1}). Three replicates were used for each treatment. Filter papers of each Petri plate were moistened with 10 ml of water or respective salt solution whenever needed. Seed germination was recorded every 24 h (AOSA, 1990) till maximum germination was recorded (9 days from start of experiment). Following formulae were used to calculate the parameters,

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1. Germination percentage (GP %) = (number of germinated seeds/total number of seeds) x 100 (till 10 days).
2. Germination Rate (GR) = Number of germinated seeds/ day (till last day of experiment (3-9 days).
3. Germination index (GI) = Σ (Gt / Dt), summation of mean number of germinated seeds per day for t days (AOSA, 1983).
   Where Gt is the number of germinated seed on day t, and Dt is the total number of days (3-9 days in this experiment).
4. Coefficient of velocity of germination (CVG) was evaluated according to Maguire (1962) as follows:

$$CVG = \frac{(G_1 + G_2 + \ldots + G_n)}{(1xG_1 + 2xG_2 + \ldots + nxG_n)}$$

   Where, G is the number of germinated seeds per day (in this experiment 3 to 9 days), and n is the last day of germination (9^{th} day).
5. Means germination time (MGT) is calculated according to Ellis and Roberts (1981) as given below,
   MGT = Σ (nd) / Σn
   Where 'n' is the number of germinated seeds in day d, Σn is the total germinated seeds during experimental period.

Table1. Mean values of germination time (MGT), germination index (GI), germination rate (GR), coefficient of velocity of germination (CVG) and germination percentage (GP %) under increasing salinity.

% Sea Salt Solution	EC_{iw} dSm^{-1}	MGT	GI	GR	CVG	GP %
0.0	0.5	0.707 ± 0.154	35.499 ± 0.751	5.556 ± 0.000	1.549 ± 0.313	100.000 ± 0.000
0.1	1.7	1.200 ± 0.200	32.934 ± 0.889	5.407 ± 0.098	0.875 ± 0.126	97.333 ± 1.764
0.2	2.8	1.126 ± 0.209	30.091 ± 1.346	4.926 ± 0.133	0.958 ± 0.192	85.333 ± 3.528
0.3	4.2	1.931 ± 0.288	22.097 ± 2.350	4.074 ± 0.323	0.539 ± 0.071	72.667 ± 4.807
0.4	5.4	2.466 ± 0.161	17.518 ± 1.221	3.556 ± 0.231	0.409 ± 0.028	63.333 ± 4.055
0.5	6.9	2.807 ± 0.493	9.773 ± 0.377	2.963 ± 0.161	0.376 ± 0.056	53.333 ± 3.333
0.6	8.6	3.760 ± 0.464	6.973 ± 1.000	2.259 ± 0.289	0.274 ± 0.034	41.333 ± 4.667
0.7	10.1	5.549 ± 0.622	3.779 ± 0.431	1.407 ± 0.225	0.184 ± 0.019	25.333 ± 4.055
0.8	10.8	Seed germination completely inhibited				
	F - Values	47.78^{***}	104.98^{***}	52.439^{***}	30.99^{***}	54.40^{***}

*******, $p<0.001$

RESULTS AND DISCUSSION

Percent Germination

Fig. 1 showed decrease in percent germination proportionate to the increasing concentration of sea salts in solution. However, increase in percent seed germination was observed with duration of time under all treatments. 80% germination was recorded at 3rd day under non-saline control (EC_{iw} = 0.5 $dS.m^{-1}$) which was continued till it became 100 % after 7 days, whereas only 25% seed were germinated at 10.1 dSm^{-1} (0.7% sea salt solution) after 9 days of treatment. Further increase in salinity (0.8% Sea Salt Solution, EC_{iw} = 10.8 $dS.m^{-1}$) complete inhibition of germination was recorded. Similar results were reported by other scientists (Dogan *et al.*, (2008) in varieties of tomato and Akinci *et al.*, (2004) in eggplant. Over a gradient of salinity due to composite of multiple salts (NaCl,

$NaHCO_3$, Na_2SO_4, $CaCl_2$) ranging from 0 to 24 $dS.m^{-1}$, the germination of eggplant has, however, been reported to decline from near 90% in control to 40% in the extreme salinity (Basalah, 2010). Cucumber seeds were more sensitive at 150 mM salt concentration and caused 90% reduced germination (Passam and Kakouriotis, 1994).

Germination rate (GR)

Fig. 2 showed highest germination rate (GR) at 3rd day of treatment in all the concentration (EC_{iw} = 0.5 to 5.4 $dS.m^{-1}$) in which emergence of radical was observed. However, the proportional decrease in GR of eggplant was found with increasing concentration up to 0.7% salinity (EC_{iw} = 10.1 $dS.m^{-1}$) along with exposure time up to 9 days. Slow in rate of germination is cause of delaying in percent germination. Jamil *et al.*, (2005) has been reported decrease germination rate of canola, cabbage and cauliflower at high salt concentrations as compare to control. Similarly, Al–Harbi *et al.*, (2008) recorded considerable low germination rate in Tomato cultivars (Pascal, Red Stone, Shohba, Super Marmand, and Tanshet Star) under salinity. Different varieties of the same species may respond differentially under salinity. Turhan *et al.*, (2011) determined highest germination rate in Green Gold at 200 mM NaCl salinity as compared to other cultivar of spinach (Ohio, Larisa and Mikado).

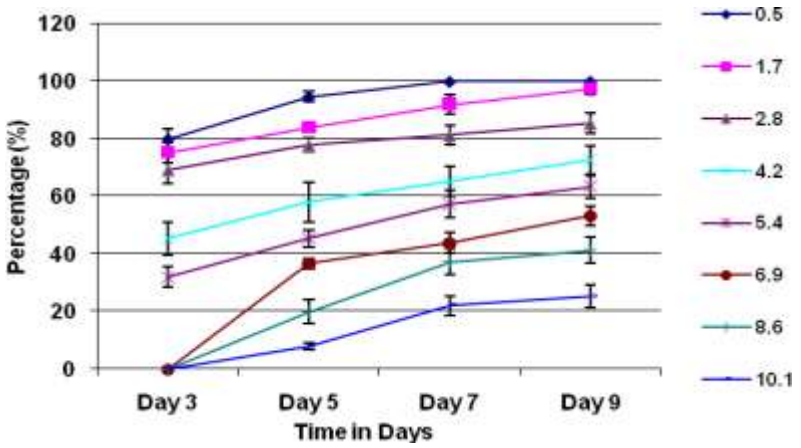

Fig. 1. Seed germination percentage of eggplant under increasing salinity level.

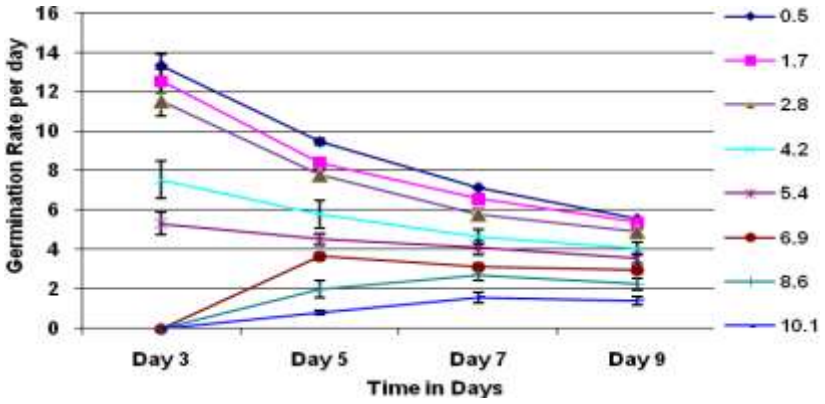

Fig. 2. Germination rate per day of eggplant under increasing salinity levels.

Germination index (GI)

Many researchers substantiate that germination indices decreased with increasing stress. Khan *et al.*, (2009) reported reduction in germination index in hot pepper. The present experiment also showed significant decrease in germination index of eggplant under increasing salinity up to 0.7% sea salt (EC_{iw} =10.1dSm^{-1}) as presented in Table

1. Xiao, *et al.,* (2012) has been observed decline germination index in Leymus species under increasing salinity up to 500 mM. Sharma *et al.,* (2013) found significant decrease in percent germination, germination speed and germination index of Indian mustard under salinity (12 $dS.m^{-1}$), whereas, mean germination time (MGT) increased under such condition.

Mean Germination Time (MGT)

Delaying in seed germination under salinity stress has been reported by many researchers (Zapata *et al.,* (2003) on *Lactuca sativa* cultivars and Redondo-Gomez *et al.,* (2008) on *Limonium emarginatum*). The present investigations presented in Table 1 revealed increase mean germination time (MGT) of egg plant seeds under elevated salinities in irrigation water (0–10.1 $dS.m^{-1}$). The results are in agreement of Hakim *et al.,* (2011). They have been found increased MGT with increasing salinity levels in all species of weeds collected from rice fields. Kandil *et al.,* (2012) recorded increase MGT in chick pea cultivars with increasing salinity (20 $dS.m^{-1}$ NaCl). Delaying of seed germination under salinity but no effect on final germination of *Prosopis juliflora* was reported by Khan *et al.* (1987). Also, according to Shannon and Grieve (1999) salinity causes delay in seed germination, however, final germination of seeds is not affected.

Coefficient of Velocity of Germination (CVG)

Table 1 revealed increasing salinity caused reduction in coefficient of velocity of germination (CVG). Highest velocity was recorded under non-saline control and the lowest value of CVG found at 0.7% sea salt solution (10.1 $dS.m^{-1}$). Rastegar *et al.,* (2011) found similar results in soybean germination. Percent germination and speed decrease significantly by deterioration as compare to control in acacia seed (Rehman *et al*. 1999). Similarly, Lanteri *et al.,* (1996) had observed delaying in speed of seed germination and germination index in pepper.

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