



EFFECT OF SALT STRESS (NaCl) ON MORPHOLOGICAL PARAMETERS OF ONION (*Allium cepa* L.) SEEDLINGS

G. Sai Sudha and K. Riazunnisa *

Department of Biotechnology and Bioinformatics, Yogi Vemana University, Kadapa, Andhra Pradesh, India.

*Corresponding author: E-mail: khateefriaz@gmail.com

ABSTRACT: Salinity is one of the major environmental factor, which affects on plant growth and development of crops worldwide, the present research is performed with four onion cultivars. Which include Agrifound dark red (AFDR), Agrifound white (AFW), LINE-28 and Krishnapuram (KP) were collected from NHRDF (National Horticulture Research and Development Foundation) Kurnool and from farmers. Selected seeds were surface sterilized with 2 % sodium hypochlorite, then placed on petriplates maintaining four levels of salinity (50 mM, 100 mM, 150 mM and 200 mM) with control. After ten days of salinity treatment seedlings of morphological traits were recorded by considering their germination percentage (GP) and germination race (GR) and seed vigor (SV) is calculated with the length of plumule (PL) and radicle (RL). Results showed that decreasing parameters were observed with increasing the levels of salinity. Among the salinity levels highest GP, GR & SV were observed in 50 mM and lowest in 200 mM concentration against control. Agrifound white is the tolerant one and LINE - 28 is susceptible to salt stress. Results may be useful in near future to know the morphological, phenotypical and ecological aspects of salt stress on plants and ultimately know the plant growth and development in salty areas.

Key words: Germination percentage, Germination race, Onion (*Allium cepa* L.), Salinity, Seed vigor.

INTRODUCTION

Salinity has a major impact on many parts of arid and semi arid regions of the world. It also has an adverse effect on the growth and development of most salt-sensitive plant species [1, 2]. Plant growth is adversely affected by salinity from decreasing the availability of water in the soil for plant consumption and because of ion toxicity from high concentrations of certain ions that contribute to salinity [3]. Nearly 20 % of world's cultivated area and half of the world's irrigated lands are affected by salinity [4]. It shows morphological, physiological and biochemical changes in the plants Processes such as seed germination, seedling growth are adversely affected by high salt concentration, ultimately causing diminished economic yield, quality and productivity [5]. It causes both ionic and osmotic stresses and affects plant growth and development [6]. The mechanism of salt tolerance cell turgor and depressed rates of root and shoot elongation, suggesting that environmental salinity acts primarily on water uptake [7]. Furthermore, high intracellular concentrations of both Na⁺ and Cl⁻ can inhibit the metabolism of dividing and expanding cells, retarding germination and even leading to seed death [8, 9].

Onion (*Allium cepa* L.) belongs to the family of Amaryllidaceae, is the second most important horticultural crop in the world after tomatoes, which is cultivated throughout the world and is extensively grown and widely consumed in India [10]. Onion seeds are convex on one side and flattened on other side and are covered by a black seed coat. Kadapa district is a cafeteria for various horticultural crops, located at the heart of Rayalaseema region. It represents semi arid climate with hot summer, the rain fall of Kadapa district is mainly influenced by south- west monsoon [11]. The soil and climatic conditions of the district are more suitable for growing wide range of horticulture crops like fruits and vegetables.

The aim of the present investigation is screening of the onion cultivars for salt tolerance at seedling stage basing on the morphological parameters like germination percentage, germination race and seed vigor. These are very important factors which describe the tolerance at the seedling level.

MATERIAL AND METHODS

In order to study the effects of salt stress, using sodium chloride. In the present study seeds of four onion cultivars which include Agrifound Dark Red (AFDR), Agrifound White (AFW), Line-28 and Krishnapuram (KP) were collected from farmers of Kadapa district and from National Horticulture Research and Development Federation (NHRDF) institute, Kurnool. Seeds of all four cultivars were first surface sterilized by using 70 % alcohol and then sterilized with 2 % sodium hypochlorite, then thoroughly washed several times with distilled water. The experiment was carried out using five salinity levels (0, 50, 100, 150 and 200 mM). 20 healthy and homogenous seeds were transferred on to the wetted filter paper. The experiment was conducted in a germination chamber at 25 °C and the observations were recorded for 10 days.

The seeds were considered germinated when the tip of the radicle had grown free of the seed coat. The Germination Percentage (GP: $N_i / N \times 100$; Where, N_i : Number of germinated seed till i^{th} day; N : Total number of seeds) [12], Germination Race (GR: $N_1 / D_1 + N_2 / D_2 + \dots + N_i / D_i$; Where, N_i : Number of germinated seeds in each numeration; D_i : Number of days till n^{th} numeration; N : Number of numeration times) [6] and Seed vigor (SV: Strong seed index = {Germination percentage \times means (RL + PL) mm} / 100; Where, RL = Radicle Length; PL = Plumule Length) [13]. Visual observations of the growth were done and were quantified on the basis of GP, GR and the lengths of plumule and radicle of the seedlings were measured for the calculation of SV. A minimum of three replicates was involved in each experiment. The analysis of variance (ANOVA) was performed with Duncan's multiple range test for different parameters using SPSS version 20.0.

RESULTS AND DISCUSSION

The aim of the present investigation is to identify salt tolerant genotypes of onion at seedling stages under different concentrations of salinity. According to the analysis of variance salt stress showed all the measured morphological parameters are significant ($p < 0.05$). The responses of all the cultivars were different to different levels of salinity. Increasing concentration of NaCl had a significant decrease in germination percentage (GP) and germination race in all onion genotypes. Reduction of GP was more at 150 mM and 200 mM concentration (Figure 1 and Figure 2) the results of our study are in good agreement with those reported by Aloui Hassen *et al.* (2014) [14] has found the same results respectively on three pepper cultivars. Decreasing of total seed germination under saline conditions is due to some metabolic disorders and also related to the reduction in water absorption into seeds [15]. As we observed in salinity stress, the most GP was high in controls and reduced in 200 mM NaCl concentration (Figure 1). Highest GP (18 %) was observed with KP at high salinity (200 mM) and lowest GP was with LINE-28 (5 %). GP decreased up to 60 % at 100 mM NaCl concentration in AFDR, 55 % in AFW, 68 % in LINE-28 and 40 % in KP onion. The highest GR was related to control, while lowest with 200 mM (Figure 2).

Table 1: Effect of salt stress on seed germination and seedling growth of different onion cultivars.

Parameter	NaCl (mM)	Onion cultivars			
		Agrifound Dark Red	Agrifound White	LINE - 28	Krishnapuram
Radicle length (cm)	0	2.68 \pm 0.18**	3.92 \pm 0.42*	5.15 \pm 0.61*	3.52 \pm 0.89*
	50	3.09 \pm 0.20*	3.34 \pm 0.07*	3.91 \pm 0.18*	3.72 \pm 0.20*
	100	2.16 \pm 0.13*	3.23 \pm 0.20*	2.74 \pm 0.42*	3.12 \pm 0.91*
	150	1.05 \pm 0.18*	1.43 \pm 0.17**	2.02 \pm 0.13*	1.79 \pm 0.15**
	200	0.61 \pm 0.16*	1.02 \pm 0.08*	0.91 \pm 0.17*	1.12 \pm 0.29*
Plumule length (cm)	0	3.76 \pm 0.12**	4.67 \pm 0.10*	5.90 \pm 0.32*	3.15 \pm 0.48*
	50	2.57 \pm 0.09*	3.41 \pm 0.72**	3.05 \pm 0.93*	2.0 \pm 0.08*
	100	1.62 \pm 0.38*	2.31 \pm 0.12*	2.83 \pm 0.32**	1.35 \pm 0.34*
	150	0.91 \pm 0.36*	1.12 \pm 0.15**	1.72 \pm 0.98*	1.21 \pm 0.68*
	200	0.45 \pm 0.17*	0.63 \pm 0.76*	0.94 \pm 0.78**	0.77 \pm 0.53*
Seed vigor (SV)	0	2.66 \pm 0.48*	3.58 \pm 0.15*	4.04 \pm 0.14*	1.44 \pm 0.82*
	50	2.80 \pm 0.28**	2.79 \pm 0.13*	2.66 \pm 0.19*	0.96 \pm 0.08*
	100	1.18 \pm 0.15*	1.33 \pm 0.17*	1.86 \pm 0.28*	0.64 \pm 0.09**
	150	1.03 \pm 0.11*	1.84 \pm 0.23*	1.58 \pm 0.52*	0.36 \pm 0.61*
	200	0.51 \pm 0.21**	0.64 \pm 0.58*	0.37 \pm 0.03*	0.15 \pm 0.58**

Values represent mean of three independent replications (\pm) SD, $P < 0.05$.

It could be due to more presence of anion, cations which in addition to toxication, decreased water potential that are because of its solubility in water. GR was affected significantly with increasing salt concentration and the reduction was more at the highest level of salt stress (150 mM and 200 mM). We also can say that this reduction in GR relies on salinity could be because of its effect on physiological processes which are effective on seed germination. The effects of salinity stress on Radicle Length and Plumule Length of four onion cultivars have been showed in Table 1. Results showed a decrease in RL and PL with an increase in salinity for the four onion cultivars. PL was more suppressed than RL by salinity at all salt concentrations [16]. In strong Seed Vigor, we have observed that there exists a significant difference ($P < 0.05$) between different salinity levels. By increasing NaCl concentration, SV index declines [17]. The most SV index was related to control and the least was related to 200 mM (Table 1). Salinity affects the quality and productivity of vegetables. Very little information is available on research in vegetable crops which have revealed that the salinity effects on GP, GR & SV [18, 19] and this is the first report on onion seedlings under the salt stress. According to Table 1, among all the four cultivars highest SV was observed with LINE-28 in control but at all salt concentrations Agrifound white is having more SV. Salinity had a significant effect on SV on all the onion cultivars i.e. AFDR, AFW, LINE-28, KP. Among all the onion cultivars LINE -28 is susceptible to salt stress and Agrifound white is the tolerant one.

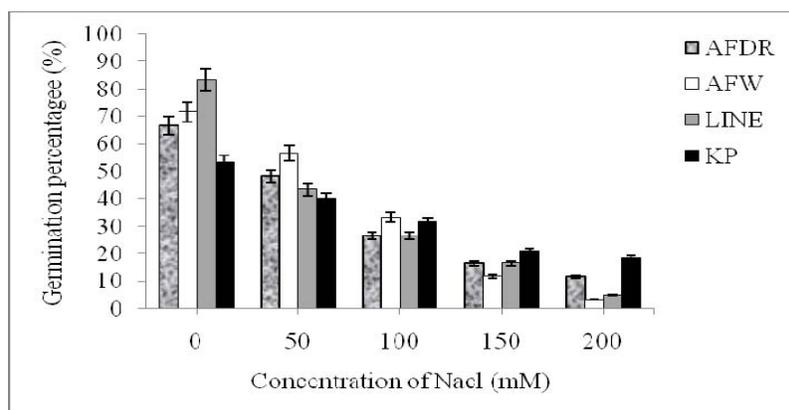


Figure 1. Effect of salt stress on germination percentage (GP) of different onion cultivars.

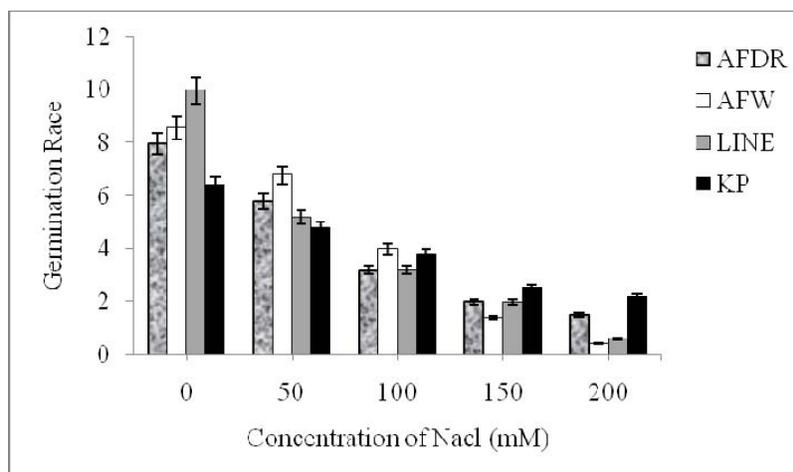


Figure 2. Effect of salt stress on germination rate (GR) of different onion cultivars

CONCLUSION

It is well known that onion is the most important horticulture crop in the world and it is used throughout the year. The yield of the crop is mainly dependent on environment, so now the research was mainly concerned to develop salt tolerant cultivars. From these studies, we conclude that salt stress induces morphological and physiological changes in onion seedlings. The current study extensively gives the information about which onion cultivar is suitable for cultivation in Kadapa climatic and geological condition. However, further research is needed for evaluating the onion cultivars for utilizing them in the breeding program.

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