Salt tolerance of three Iranian Millets at seedling stage

Shahla Sharifian ¹* and Kourosh Delavar ²

¹. Department of Biology, Payame Noor University, Tehran, Iran
². Department of Biology, Ashtiyan Branch, Islamic Azad University, Ashtiyan, Iran

Abstract

Salt stress is considered as a restricting factor for plant products. Various species have different levels of tolerance to salt stress. In this research seeds of Millet (Panicum miliaceum L.), cultivars (Talkhonche, Shiraz and Isfahan) were put in Petri dishes under 0, 200, 300 and 400 mg/lit concentrations of NaCl in the same light condition for one week. The seeds of Millet after sterilization were treated by different concentrations of NaCl and after germination some physiological traits were determined in treated 1 week old seedlings. Our results showed that salinity increased fresh and dry weight of shoot, fresh weight of root and chlorophyll content in Talkhonche cultivar, and in Isfahan cultivar these parameters and dry weight of root were decreased. In Shiraz cultivar, fresh and dry weight of shoot and fresh weight of root increased by salinity. Results of this study showed that Talkhonche cultivar was salt resistance; Shiraz cultivar semi-resistance and Isfahan cultivar was salt sensitive in seedling stage.

Keywords: salt stress; millet; chlorophyll; seedling


Introduction

Salinity is one of the major environmental factors limiting plant growth and productivity (Parida and Dus, 2005). The NaCl is the predominant salt in most saline environments (Zörb et al., 2004). The UNEP (United Nations Environment Program) estimates that 20% of agricultural and 50% of the cropland in the world is salt-stressed (Tavili and Biniaz, 2009). Many crop species are sensitive to high concentrations of salt with negative impacts on agricultural production (Zörb et al., 2004). An important consequence of salinity stress in plants is the excessive generation of reactive oxygen species (ROS) (Abdul Jaleel, 2009) such as super oxide anion (O₂⁻) and hydrogen peroxide (H₂O₂) particularly in chloroplasts and mitochondria (Desingh and Kanagaraj, 2007). Plant cells must be able to maintain low cytoplasmic Na⁺ to tolerate salt stress. Salt resistance is a complex mechanism involving many different responses against cellular osmotic and ionic aspects of Na⁺ (Tajdost et al., 2007). Plants under stress produce some defense mechanisms to protect themselves from the damages. Salt stress affects many physiological parameters of plant growth. Shoot and root growth reduce by salinity due to inhibitory effect of salt on cell division and
enlargement in growing point; while matter reduces, root-shoot ratio increases by salt stress (Maghsoudi and Maghsoudi, 2008). The present study aims at investigating the effects of salt stress in millet seedlings.

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Materials and Methods

Seeds of three cultivars of Panicum miliaceum L. (Talkhonche, Shiraz and Isfahan) were obtained from Isfahan agricultural research center. The present study was conducted at Isfahan Payame Noor University. Surface of seeds were sterilized in 12% sodium hypochlorite solution for 20 minutes and placed on Whatman filter paper in Petri dishes with 200, 300 and 400 mg/lit concentrations of NaCl. Also 5 ml of distilled water was added to control treatment. Then samples were placed in the same light and temperature for one week and dry and fresh weights in shoot and root of the treated seedlings and their Chlorophyll contents were measured.

Dry and fresh weights

The shoot and root fresh weights of 20 seedlings were weighed and then the samples were dried in oven at 70 °C for 42 h, and the dry weights were determined.

Chlorophyll content

Chlorophyll concentration was determined from fully expended leaves. A leaf sample of 0.1 g was extracted with 5 ml of 80% acetone in the dark. The mixture was filtered and its absorbance was determined at 648, 663 and 450 nm. The concentration of chlorophyll a, chlorophyll b and chlorophyll (a+b) were estimated through the method suggested by Lichtenthaler (1987) using the following formulas for calculation:

\[
\text{Chl} \ a \ (\text{mg.ml}^{-1}) = (12.25A_{663.2}) - (2.79A_{648.8}) \\
\text{Chl} \ b \ (\text{mg.ml}^{-1}) = (21.51A_{646.8}) - (5.1A_{663.2}) \\
\text{Chl} \ T \ (\text{mg.ml}^{-1}) = \text{Chl} \ a + \text{Chl} \ b
\]

Data analysis

All analyses were done on a completely randomized design. The obtained data were subjected to one-way analyses of variance and the mean data were compared by Duncan test. Data analyses were performed by SPSS software.

Results

Shoot fresh weight

In Talkhonche cultivar shoot fresh weight significantly increased by salinity compared to control plants. In Shiraz cultivar shoot fresh weight significantly increased when seedlings were treated with 300 mg/lit NaCl. In Isfahan
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culturav shoot fresh weight significantly decreased when seedlings were treated with 400 mg/lit NaCl (Fig. I).

In each column the same letters are not significantly different at P≤ 0.05 by using Duncan’s multiple range tests.

**Shoot dry weight**

In Talkhonche and Shiraz cultivar shoot dry weight significantly increased when seedlings were treated with 300 mg/lit NaCl. In Isfahan cultivar however, shoot dry weight significantly decreased when seedlings were treated with 300 and 400 mg/lit NaCl (Fig. II).

In Shiraz cultivar root dry weight significantly increased in 300 mg/lit NaCl and significantly decreased when seedlings treated with 400 mg/lit NaCl. The results showed that in all salinity treatments root fresh weight were decreased in Isfahan cultivar (Fig. III).

In Shiraz cultivar root dry weight significantly decreased in seedlings which were treated with 200 mg/lit NaCl. In Isfahan cultivar root dry weight significantly decreased in 300 and 400 mg/lit NaCl (Fig. IV).

**Root dry weight**

In Shiraz cultivar root dry weight significantly decreased in seedlings which were treated with 200 mg/lit NaCl. In Isfahan cultivar root dry weight significantly decreased in 300 and 400 mg/lit NaCl (Fig. IV).

**Chlorophyll content**

In Talkhonche cultivar content of chlorophyll (a+b) significantly increased in seedlings treated with 200 and 400 mg/lit NaCl.
and in Isfahan and Shiraz cultivar content of chlorophyll \((a+b)\) significantly decreased in all level of salinity (Fig. V).

![Fig. V. Effects of salt stress on content of chlorophyll a+b of three millet cultivars. In each column the same letters are not significantly different at P≤ 0.05 by using Duncan’s multiple range tests.](image)

**Discussion**

Salinity of soil and water is caused by the presence of excessive amounts of salt. Most commonly, high Na\(^+\) and Cl\(^-\) cause the salt stress. Salt stress has three effects, namely, reduction in water potential, ion imbalance or disturbances in ion homeostasis and toxicity. These circumstances lead to limitation in plant growth and productivity. Salt stress causes both osmotic and ionic stress (Parida and Dus, 2005). In this investigation when NaCl concentration increased morphological parameters in three cultivars were changed. For instance, fresh and dry weight of shoot, fresh weight of root and content of chlorophyll in Talkhonche cultivar were increased by increasing salinity. However, these parameters as well as the dry weight of root were decreased in Isfahan cultivar. Decreasing of morphological parameters is similar to results that had been reported by Jamil et al. (2007) who had observed that dry and fresh weights are significantly inhibited in cabbage \((Brassica oleracea capitata L.)\) when treated with salinity. Also Hamid et al. (2008) had indicated that salt stress in wheat significantly reduced content of chlorophyll and all growth parameters. Expressed high salinity may inhibit some parameters in plant due to slowing down the water uptake and decreases of osmotic potential by stress (Jamil et al., 2007). Our findings in Isfahan cultivar showing that content of chlorophyll was decreased by salt stress may be due to an increase the activity of chlorophyllase (Najafi et al. 2006). It is similar to finding of Turan et al., (2009) in Maize. But in Talkhonche cultivar some parameters were increased by salinity condition due to activity of protective mechanism for salt tolerance (Maghsoudi and Maghsoudi, 2008). Therefore from the view point of salt tolerance in seedling stage, these cultivars are arranged as Talkhonche, Shiraz and Isfahan according to our results.

**References**


