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RESPONSE OF NaCl ON MORPHO-PHYSIOLOGICAL PARAMETERS AND NITRATE REDUCTASE ACTIVITY IN FINGER MILLET (*ELEUSINE CORACANA*)

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ABSTRACT
Eleusine coracana or finger millet is well known as super cereal for its excellent nutritional value, long term storage potential and ethno-medicinal characteristics. The experiments were conducted to study the effect of salinity stress on ragi plant at different NaCl concentrations (100mM, 200mM and 300mM NaCl) and untreated plants were kept as control. Growth parameters such as height of plant, leaf area and biomass as well as activity of nitrate reductase enzyme and reducing sugar content were studied. The results of the experiment showed that biomass of the plants increased with stress as compared to the control and maximum increase was found at 100mM NaCl concentration. Plant height, leaf area and nitrate reductase activity increased in treated plants compared to control plants. The results indicated that the ragi (*Eleusine coracana*) can tolerate moderate salinity stress.

KEYWORDS: *Eleusine coracana*, Biomass, Nitrate reductase, Reducing sugar, Plant height, Leaf area.

INTRODUCTION

Salt stress is one of the world's most serious environmental problems in agriculture, affecting 7% of the world's land area (Dida *et al.*, 2008). Salt stress is one of the major abiotic stresses especially in arid and semi-arid regions and can severely limit plant growth and yield (Parvaiz and Satyawati, 2008). Tolerance to abiotic stresses is complex at the whole plant and cellular level (Fooded *et al*., 2003a, Ashraf and Harris, 2004, Munna and Teaster, 2008, Grewal, 2010). This is in part due to the complexity of interactions between stress factor and various molecular, biochemical and physiological phenomena affecting plant growth development (Zhu, 2002). Salt stress affects many aspects of plant metabolism, such as reduced growth. Photosynthesis is reduced because it is affected by leaf area and leaf duration, as well as by respiration per unit leaf area. Mineral uptake by roots is affected as a result of imbalance in the availability of different ions. Furthermore, a decrease in nitrate reductase activity and an inhibition of photosystem-II and chlorophyll breakdown are associated with increased Na^+ accumulation in plant tissues (Krishnamurthy and Bhagwat, 1995). *Eleusine coracana or* finger millet (family Poaceae) is grown in four million hectares of land. It is usually raised as kharif crop. It is grown successfully in areas where temperature is more than 27^0C. Finger millet a staple food crop is well known as a super cereal for its excellent nutritional value, long term storage potential and ethno- medicinal characteristic. Finger millet is nutritionally superior to rice and wheat and it provides cheap source of proteins, minerals vitamins to the rural population (Latha *et al.*, 2005). Currently, there are no economically viable technological means to facilitate crop production under stress condition. However, development of crop plants tolerant to environmental stresses is considered a promising approach, which may help satisfy growing food demands of the developing and under-developed countries. In this present study, we investigated the effect of NaCl on morpho-physiological and biochemical response of ragi plant to moderate and severe experimental stress conditions, for improving its productivity under Salinity.

MATERIALS & METHODS

The grain of finger millet were obtained from National Seed Corporation Gorakhpur and grown in earthenware pots containing sterilized sand and supplemented with full strength of Hoagland's nutrient solution. The seedlings of test plant were treated with different concentration of NaCl solution (100mM, 200mM and 300mM) at every seven days interval. Untreated plants were kept as control. Ten days old ragi seedlings were sample for observation. Morphological parameters as biomass of plant, height of plant and leaf area. Total dry weight of plant obtained after oven drying at 60^0C for 72 hours. Total dry weight per plant was recorded at every ten day interval from 40day upto 90 day with each salt concentration. Plant height was measured from the attachment point of root and stem upto the slip of upper most fully opened leaf. Leaf area in finger millet is the exposed lamina of the leaf and is usually termed as leaf area. The leaf area was calculated by the method advocated by Singh (1970) in wheat.

$$A=L\times W\times 0.877 \text{ (constant)}$$

Nitrate reductase activity was assayed in primary leaves of different days. The NR activity was measured by the *in-vivo* method following the procedure of Streeter and Bosler (1972) with slight modification. Total reducing sugar was assayed in dried leaves of different days. The total reducing sugar was estimated by Somogyi's method (1952).

RESULTS & DISCUSSION

NaCl stress caused a significant variation in shoot length and biomass' of ragi plant. However, shoot length and dry weight appreciably increased with plant age for every NaCl concentration *i.e.* 100mM, 200mM and 300mM (Fig1 and 2).

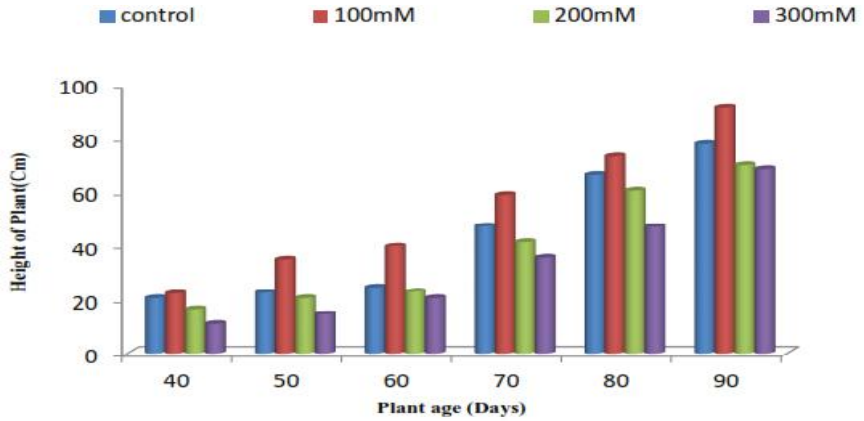

FIGURE 1: *Eleusine coracana*: Plant Height at different age of plant growth treated with different NaCl concentration

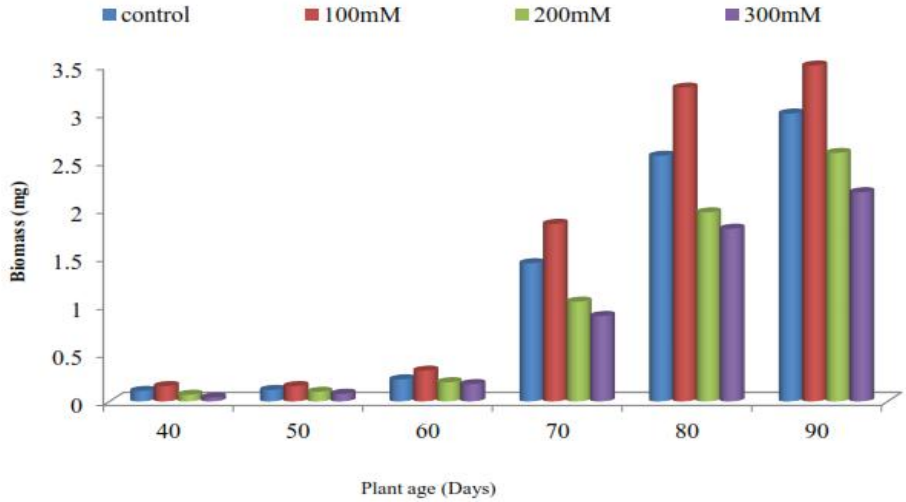

FIGURE 2: *Eleusine coracana*: Biomass at different age of plant growth treated with different NaCl concentration

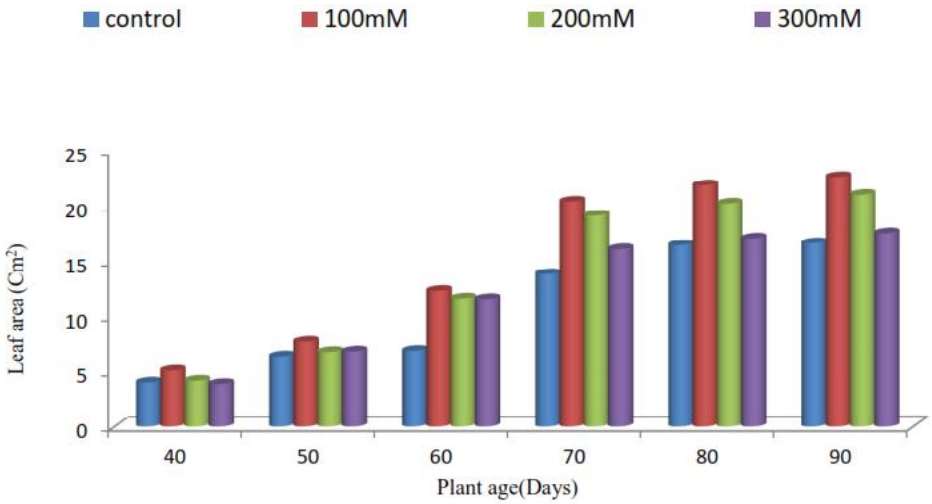

FIGURE 3: *Eleusine coracana*: Leaf area at different age of plant growth treated with different NaCl concentration

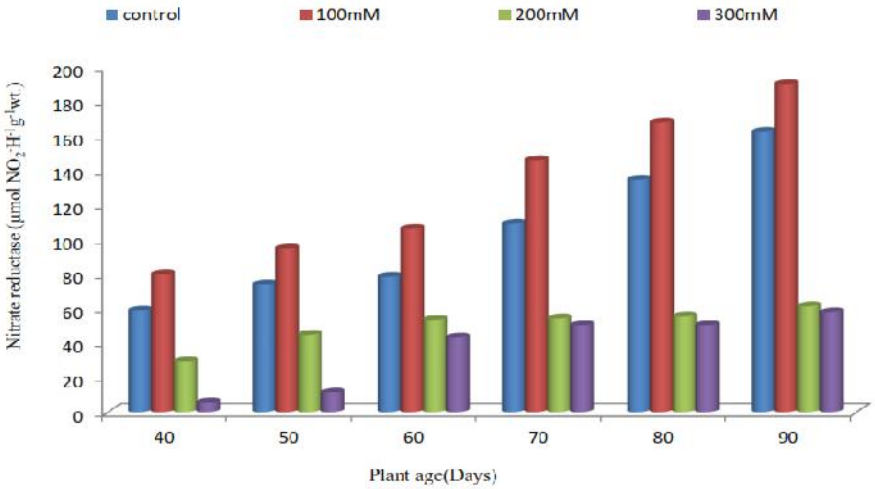

FIGURE 4: *Eleusine coracana*: Nitrate reductase at different age of plant growth treated with different NaCl concentration

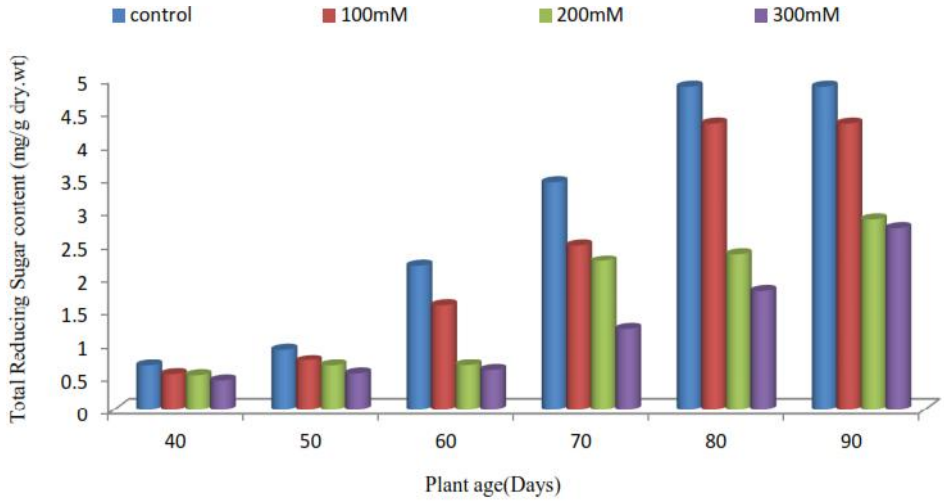

FIGURE 5: *Eleusine coracana*: reducing sugar at different age of plant growth treated with different NaCl concentration

Maximum shoot length and biomass was recorded in plants treated with 100mM NaCl while maximum reduction was seen in biomass of plants treated with 300mM NaCl salt concentration compared to control. Salinity inhibits plant growth has been extensively studied in many plants *e.g.* in rice (Alam *et al*., 2004), corn (Bar-Tal *et al*., 1991), tomato (Satti and Al-yahyal, 1995), spinach, cucumber and pepper (Kaya *et al*., 2001a) and cotton (Leidi and Saiz, 1997). Applied NaCl inhibited the growth of maize plant with decrease in both shoot and root dry weights. At low levels of NaCl (0 and 25 mM) relatively higher dry weights were reported and did not imply toxicity symptoms, however, the growth was significantly reduced at higher levels of salinity (50, 75 and 100 mM) indicating the symptoms of salt toxicity as growth depression (Murat *et al.*, 2010). This reduction in plant biomass might have been due to limited supply of metabolites to young growing tissues (Mass and Nieman, 1978). Leaf area of ragi plant increased with plant age for every NaCl concentration. Maximum increase in leaf area was recorded at 100 mM NaCl (Fig. 3). Ashraf and Parveen, (2002) reported marked reduction in shoot fresh and dry masses and leaf area per plant at higher NaCl concentrations in salt tolerant and salt sensitive cultivars of wheat. Comparison of the cultivars showed that salt tolerant had significantly greater shoot fresh and dry masses, and leaf area per plant. Nitrate reductase (NR, EC 1.6.6.1), localized in the cytoplasm, is the first enzyme in the pathway of nitrate assimilation and catalyses the reduction of nitrate to nitrite. In the present study, NR activity increases with plant age for every NaCl concentration (Fig 4). NR activity was significantly inhibited by salt treatment at higher concentration *i.e.* 300mM. Similar observation was made Bybordi and Ebrahimian (2011) in conola. Decrease in nitrate reductase is not due to direct inhibitory effect of salinity stress, it may be due to reduction in nitrate uptake (Billard and Boucard, 1982). Yadav *et al.* (1999) observed an increase in NR activity in gram plants sprayed with BAP during water stress. Total Reducing Sugar content increased with plant age for every NaCl concentration (fig 5).There was a considerable decrease in the contents of total reducing sugar at different NaCl concentration as compared to control. In the present study higher content of sugar was maintained in the control plants as compared to the plants under Salinity.

CONCLUSION

Finger millet showed tolerance under low NaCl level (100mM) by increment in height of plant, leaf area, biomass, NR activity and total reducing sugar content leading to better growth and biomass for better crop production under salinity.

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METRIC SYSTEM

Cm^2: Centimeter
mM: mili mole
µmole: micromole
mg: milligram
g: gram
^{0}: for degree
NR: Nitrate reductase
EC: Electrical conductivity
Wt: Weight
Fig.: Figure