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Research article

FOLIAR APPLICATION OF MANGANESE FOR INCREASING SALINITY TOLERANCE IN MUNGBEAN

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ABSTRACT: Pot experiments were carried out to determine the effect of salt stress (100, 200 and 300mM NaCl) on growth and antioxidant enzymes of mungbean. Seeds were inoculated with *Rhizobium* and sown in earthenware pots. Plants were treated with saline water of 100, 200 and 300mM NaCl concentration. Foliar application of Mn (0.15%) was given to the salt treated plants. The results revealed that there was a drastic reduction in growth parameters of mungbean plants through decrease in plant height, biomass, leaf area, number of leaves at higher salt concentrations (i.e. 200mM and 300mM NaCl concentration). This condition lead to an alteration in the antioxidant enzymes viz. Catalase and Peroxidase activity. Foliar spraying with Mn introduced stimulatory effects on growth characteristics and a significant increase in antioxidant enzymes also. The results of this study suggests that foliar application of Mn has a crucial role for increasing tolerance of mungbean plants to salinity stress.

Key words: Salt stress, antioxidant enzymes, biomass, Mn, foliar spray

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INTRODUCTION

Mungbean (*Vigna radiata* (L.) R. Wilczek) is native to India and is cultivated since ancient times. It is a fast growing warm season dryland legume crop with short growing season. This crop plays a crucial role not only in human diet, but also in improving the soil fertility by fixing atmospheric nitrogen with the help of *Rhizobium* present in root nodules (Ashraf *et al*., 2003).

Among abiotic stresses, salinity stress is an important stress as it causes significant reduction in crop production (Saha *et al*., 2010). Salinity stress induces oxidative stress, leading to the formation of ROS, hence, salt tolerant plants beside adjustment of ion and water, should have defensive systems against oxidative stress for scavenging and effective elimination of Reactive Oxygen Species (ROS) (Tabatabaei, 2013). Plants stimulate many protective mechanisms to neutralize harmful possessions of ROS.Those plants which contained high level of antioxidant enzymes have more resistance against oxidative stress caused by ROS (Khan *et al*., 2009; Gapinska *et al*., 2008). Enzymes such as superoxide dismutases (SODs), catalases (CATs), and peroxidases (PODs), as well as low molecular mass antioxidants, including ascorbate and reduced glutathione (GSH), are used to scavenge different types of ROS (Foyer *et al.* 1994).

Micronutrients in minuscule amounts are essential for plant growth, physiology and yield. Micronutrient deficiency in plants is widespread due to calcareous nature of soils, high pH, low organic matter, salt stress, continual drought, high bicarbonate content in irrigation water and imbalanced application of fertilizers (Malakouti *et al*.,2008).

Foliar application is an agricultural practice of increasing growth and yield of crops. (Fernandez and Eichret, 2009). Manganese (Mn) is an essential plant micronutrient that is involved in the activation of many enzymes in plant systems, mostly in oxidation, reduction, decarboxylation and hydrolytic reactions (Marschner, 1995). Deficiency of Mn induces inhibition of growth, chlorosis and necrosis, early leaf fall and low reutilization (Sajedi *et al*., 2009).

The aim of the present investigation is to study the effect of salinity and role of foliar application of Mn on growth and antioxidant enzymes of mungbean plants in ameliorating the inhibitory effect of salinity.

MATERIALS AND METHODS

Seeds of mungbean plants were surface sterilized and inoculated with *Rhizobium* and then germinated in growth chamber under controlled conditions (Temp. 25 ± 2ºC). Three days old plantlets were transplanted to earthenware pots containing sand. The pots were supplied with Hoagland's nutrient solution at 5 day interval. Plants were treated with water containing different concentrations of NaCl (100, 200, 300mM) at 7 day interval. Untreated plants were kept as control. Foliar application of $MnCl_2$ solution (0.15%) was given at 15, 30,45 days after planting.

The collection of samples was done at every 10 day and various growth parameters such as number of leaves, leaf area, plant height, biomass, antioxidant enzymes such as catalase and peroxidase were analyzed from 10 DAS up to 50 DAS. Oven dried plants were used for estimation of biomass. Leaf area was calculated by the method of Singh (1970). Catalase was estimated by method of Chance and Maehly (1955) and Peroxidase was determined by the method of Shannon *et al*. (1966). The data have been statistically analyzed. Least significant difference (LSD) has been calculated for the data where F-test is found significant.

RESULTS AND DISCUSSION

Growth parameters like number of leaves (Fig.1.), plant height (Fig.2.), leaf area (Fig.3.) and biomass (Fig.4.) in *Vigna radiata* under salinity stress alone and in combination with foliar application of $MnCl_2$ were studied. Stress condition caused a decrease in plant height at 200mM and 300mM NaCl concentration. But an increase was recorded at 100mM NaCl concentration in all the above growth parameters. Similar result of shoot length has been recorded for *Pennisetum alopecenoids* by Mane *et al*., (2011). From the present result it is evident that plant height and other growth parameters viz. number of leaves, leaf area and biomass were stimulated at lower salt concentration and decreased at higher concentration. Morphological changes in the present study might be due to reduction of metabolic activity of the cell and hence stunted growth at high salt concentration.

Foliar application of Mn significantly increased all the growth parameters at all levels of stress. However significant effect was observed in 200 mM NaCl treated plants. A significant effect of micronutrient on growth parameters including yield of mungbean plants by foliar application of Zn, Mn, Fe under water stress was observed by Kassab (2005). Enhanced effect of foliar application might be attributed to the favourable influence of these nutrients on metabolism and biological activity and its stimulating effects on enzymatic activity which in turn enhances vegetative growth of plants (Michail *et al*., 2004). The observed results are in agreement as reported in mungbean plants (Thalooth *et al*., 2006), sunflower (Jabeen *et al*., 2011) and in wheat (El-Fouly *et al*., 2011).

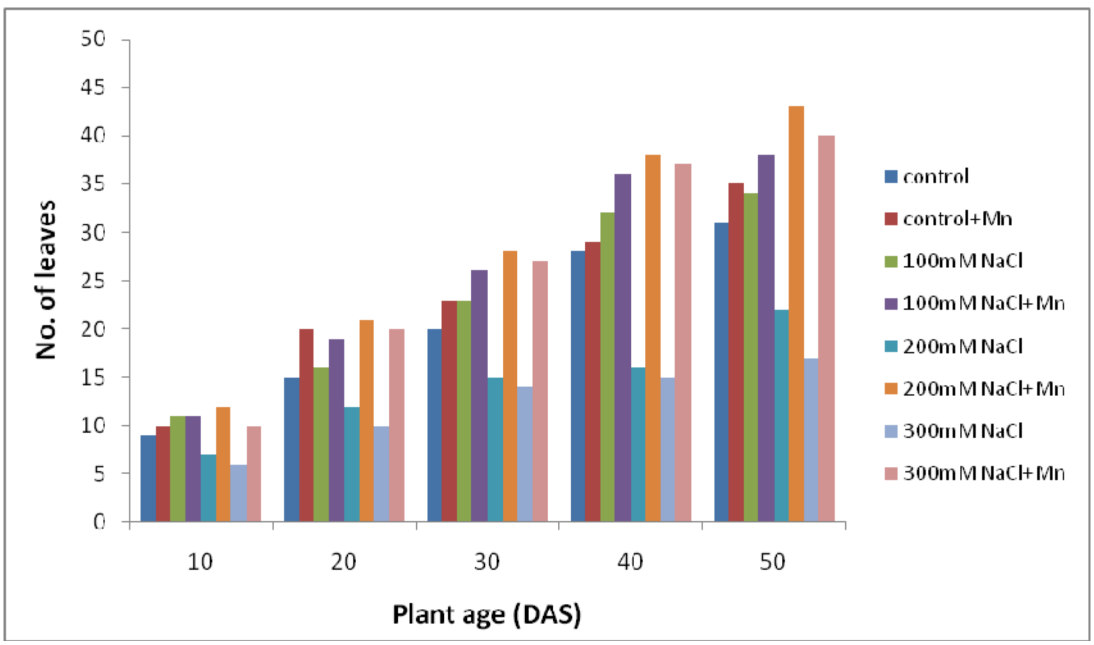

Fig: 1. *Vigna radiata*: Number of leaves at different days of plant growth under different salinity level alone and in combination with $MnCl_2$. (LSD = 2.15)

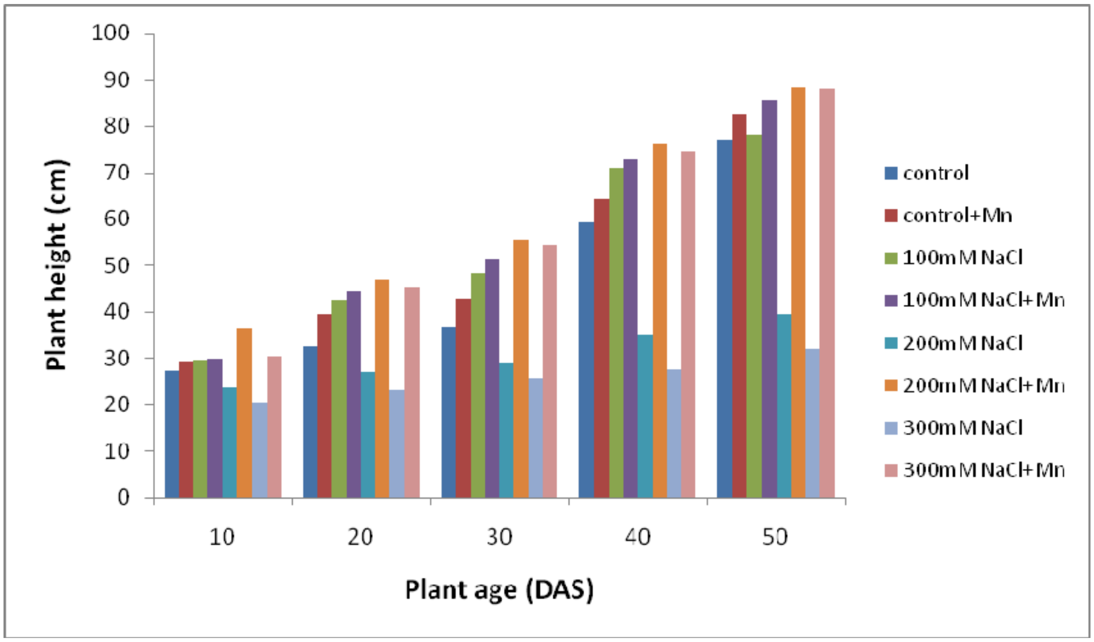

Fig: 2. *Vigna radiata*: Plant height at different days of plant growth under different salinity level alone and in combination with $MnCl_2$. (LSD = 4.36)

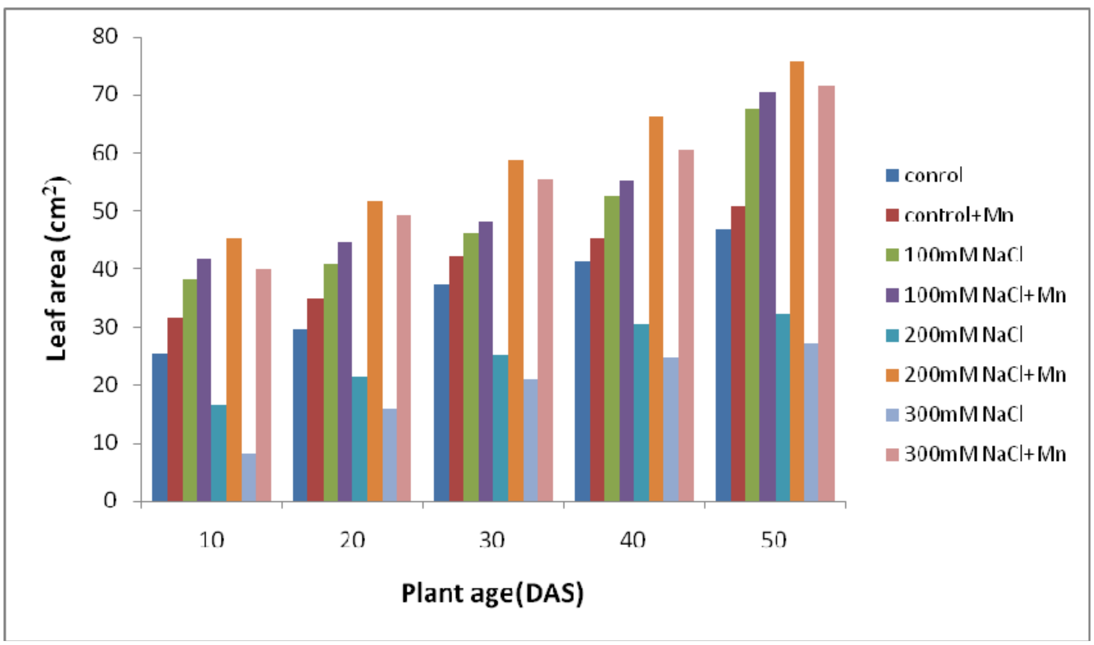

Fig: 3. *Vigna radiata*: Leaf area at different days of plant growth under different salinity level alone and in combination with $MnCl_2$. (LSD = 3.29)

In present investigation, it is seen that Mn elevated the growth parameters of the moderately stressed (200mM) plants more efficiently than extremely stressed plants (i.e. 300mM NaCl). The overall comparative pattern of promotion in growth parameters with interaction of salt stress and Mn spray is as follows- Control< 100mM< 300mM< 200mM which was 300mM<200mM<control<100mM in only saline conditions.

Furthermore, antioxidant enzymes increased with increased salt exposure (Fig.5. and Fig.6.). The results are in conformity with Amruta *et al* (2014) in groundnut and Janmohammadi *et al.* (2012) in castorbean. But the amount of POD & CAT did not increase linearly in 300mM NaCl stressed plants as compared to control, 100mM and 200mM NaCl treated plants which showed that ROS produced due to stress cannot be scavenged so efficiently as in 100mM and 200mM NaCl treated plants. Hence, the growth was severely affected.

Activity of POD and CAT was maximum at 30 DAS. In the present work, when Mn was sprayed, the amount of antioxidant enzymes was enhanced in 300mM NaCl treated plants revealing that manganese has its involvement in activation of antioxidant enzymes (Santandrea *et al*., 2000).

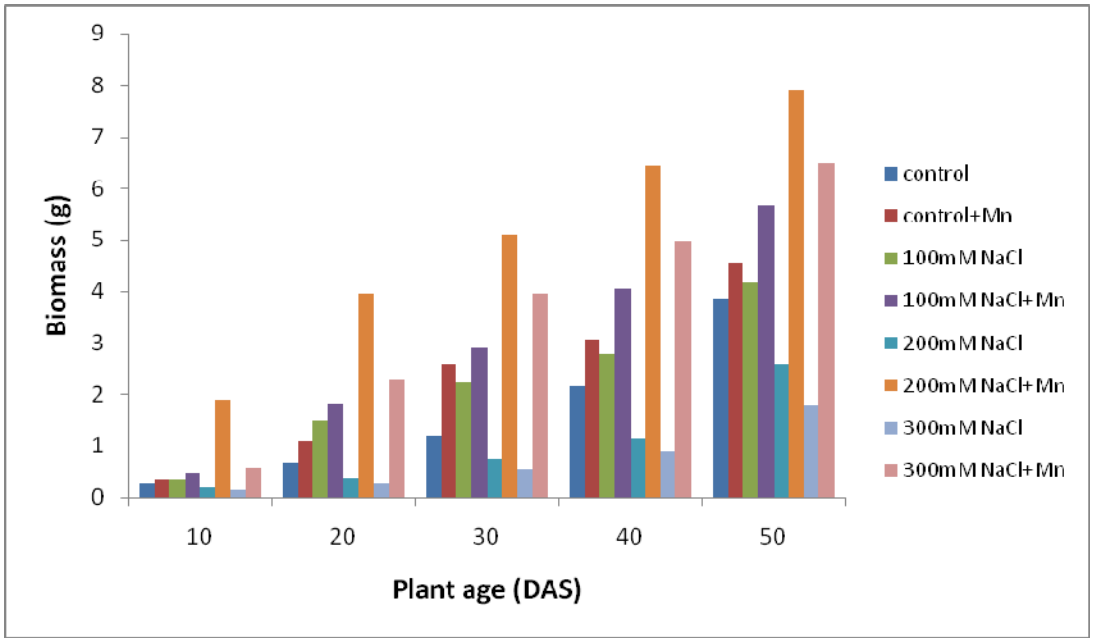

Fig: 4. *Vigna radiata*: Biomass at different days of plant growth under different salinity level alone and in combination with $MnCl_2$. (LSD = 0.419)

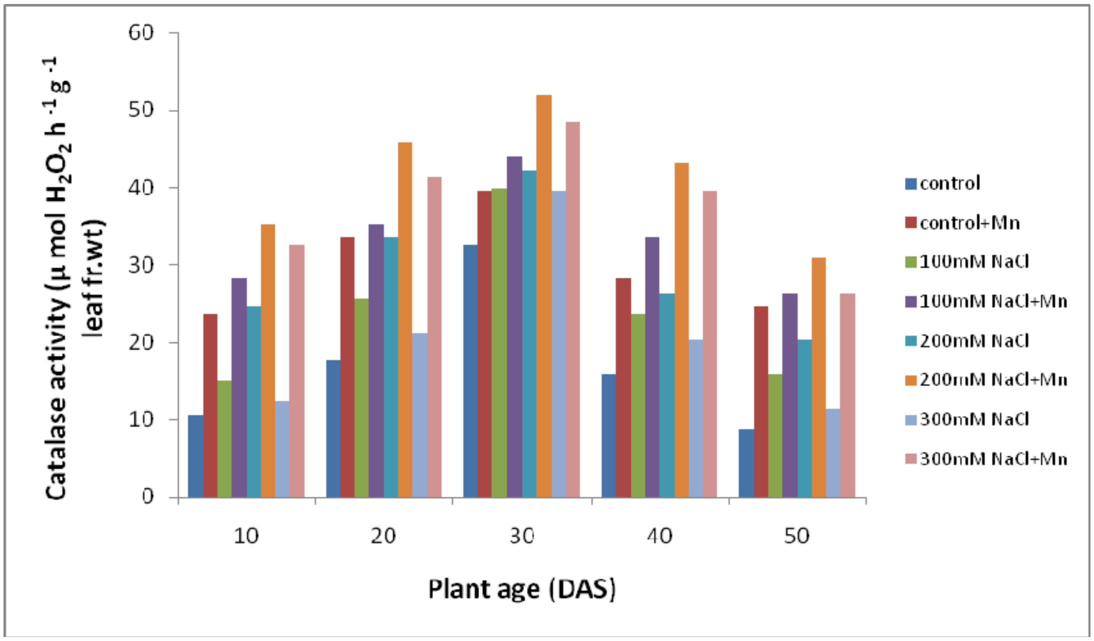

Fig: 5. *Vigna radiata*: Catalase activity at different days of plant growth under different salinity level alone and in combination with $MnCl_2$. (LSD = 2.28)

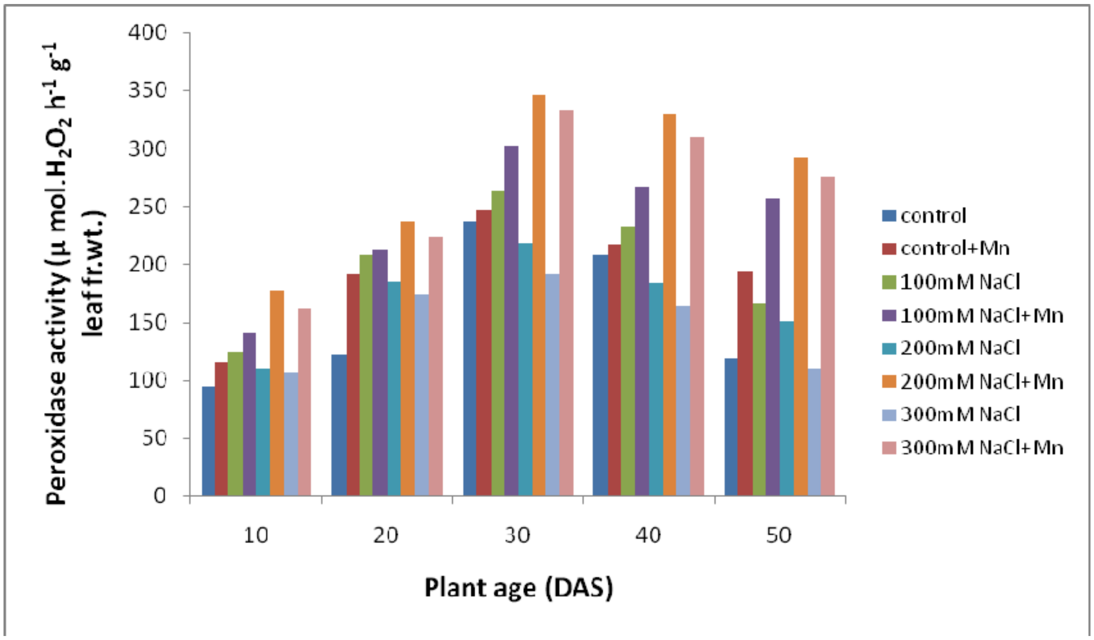

Fig: 6. *Vigna radiata*: Peroxidase activity at different days of plant growth under different salinity level alone and in combination with $MnCl_2$. (LSD = 14.12)

CONCLUSION

The present work revealed that salinity caused changes in morphological parameters and antioxidant enzyme activity in mungbean plants. Foliar spraying with Mn under these conditions can enhance the tolerance of mungbean plants by increasing the ROS scavenging systems and could mitigate the detrimental effects of salinity stress in mungbean plants effectively.

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