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Original Article

Impact of Salinity Stress on Growth Attributes of Some Salt-Sensitive and Tolerant Lines of Mung Bean (*Vigna radiata* L.)

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Abstract

Soil salinity is distinguished in primary and a secondary salinity. The primary one is a consequence of natural processes of rock disintegration that release soluble salts, such as chlorides of sodium, calcium and magnesium, sulphates and carbonates into water, which are deposited in soil solution through the wind and rain. The most easily transported salt in this process is sodium chloride. This study investigates the impact of salinity stress in salt-sensitive and salt-tolerant cultivars of Vigna radiata, commonly known as mung bean. Experiment was conducted in petri dishes and 120 mM NaCl was applied. The study reveals distinct differences in the salt-sensitive and salt-tolerant lines of V. radiata. Salt-sensitive cultivars exhibited reduction in their shoot & root fresh and dry biomass. In contrast, salt-tolerant lines showed minimum reduction in their biomass (fresh & dry). 07006MB and 08009MB showed slight increase in their fresh and dry shoot biomass under 120mM NaCl. Similarly, root fresh biomass was slightly increased in 07006MB and 14005MB, but dry root biomass was observed maximum in line 14005MB as compared to other lines under 120 mM NaCl. These findings provide valuable insights into the adaptive strategies of salt-tolerant cultivars, offering a basis for targeted breeding programs aimed at enhancing salinity resilience in this economically significant legume. In summary, this research deepens our understanding of the impact of salinity stress on growth pattern of Vigna radiata lines. It lays the groundwork for developing robust crop varieties capable of thriving in saline environments.

INTRODUCTION

Saline salinity simply defined as "When excessive concentration of soluble salts is present in the soil, such type of soil is said to be saline". These salts are Na, K, Cl, Mg, Ca, and HCO_3 etc. Salinity is the major environmental factor limiting plant growth and productivity. Based on the soil map of the world, the total area of saline soil is 397 million hectares (Mha) which is approximately 3.1% of the world's land area [1]. Pakistan is a predominantly a dry land country with 80 percent of its land falling in arid and semi- arid regions. The salt-affected soils in irrigated and non-irrigated areas of Pakistan are about 6 million hectares. The latest surveys (2001-2003) by SMO, WAPDA indicate that 27 percent soil has surface salinity and 39 percent soil has profile salinity problems in Pakistan [1]. Due to salinity plant productivity decreases which causes a decrease in carbon input to the soil, microbial activity and therefore Soil Inorganic Carbon (SOC) decomposition rates. Historically, using a modified Rothamsted Carbon Model (RothC) it is estimated that world soils that are currently saline have lost an average of 3.47 t SOC ha^{-1} since they became saline [2]. The unfavorable impacts of high salt on plants can be seen at the entire plant level as the demise of plants or abatements in profitability. Many plants create components either to prohibit salt from their cells or endure its essence inside the cells. Amid the onset and improvement of salt worry inside a plant all the significant procedures, for example, photosynthesis, protein combination, and vitality and lipid digestion are influenced. The most punctual reaction is a diminishment in the rate of leaf surface extension, trailed by a discontinuance of development as the anxiety strengthens. Salinity inflicting important reduction in crop yield because of soil salinity affects giant areas of the world 's land. There are many reports which show that salinity induces water deficient in many crop species such as corn, sunflower, potato, and soybean. Maize belonging to Poaceae family of C_4 type is reported as salt susceptible. Salt anxiety emphatically impacts plant development and advancement, particularly maize plants, which are accounted for as salt delicate species [3]. A primary response in salt stressed plants is a decrease in plant water potential, resulting in decreased water use efficiency, leading to the overall toxic damages and yield reduction. Salt stress is also found to impair the cellular electron transport within the different sub cellular compartments and results in generation of ROS [4]. Thus, ROS are called cellular indicators of stresses in addition to secondary messenger actively involved in the strain response signaling pathways. Plants are capable to detoxify ROS by producing-by-producing different types of antioxidants [5]. Mung bean is botanically recognized as *Vigna radiata*. Mung bean is commonly known as green gram and is widely distributed Asiatic spp. It has diploid number of chromosomes (2n). The genus Vigna include 150 spp are native to India, 16 to South Asia and the largest number of spp are found in Africa. The primary objectives of this study were to observe the impact of salinity stress on some tolerant and sensitive lines of mung bean [6].

RESEARCH METHODOLOGY

The present study was conducted to investigate the influence of salinity on the salt sensitive and tolerant lines of *Vigna radiata*. The 9 lines of Vigna radiata (07008, A2R106, 08009, 07006, 12007, NM-06, NM-11, 14006, 14005) were collected from Ayub Agricultural Research Institute (AARI), Faisalabad Pakistan. The initial trial took place in Petri dishes within the Botany lab at Punjab College Mian Channu, District Khanewal, for preliminary screening purposes, including germination and seedling assessment. This phase aimed to identify salt-tolerant and salt-sensitive lines of Vigna radiata. The seeds chosen for the experiments were healthy, of regular size, free from blemishes, and exhibited uniform characteristics, ensuring consistency in the experimental setup. Common procedures were followed across all three experiments to maintain methodological coherence.

Screening

The study took place at Punjab College Mian Channu, utilizing 120 Petri plates as experimental units. Each Petri plate accommodated 8 to 10 seeds, and the experimental design followed a completely randomized setup with two treatments: control and saline (with salinity levels of 0 mM &120 mM NaCl). To mitigate evapo-transpiration and prevent dryness, filter paper was employed within the Petri plates. Additionally, Hoagland solution was administered to supply essential nutrients. The germination period spanned 4-6 days.

Harvest

The plants were harvested three weeks after sowing. The following stages were undertaken during the harvest process.

Biomass

Plants were harvested and separated into shoots and roots after drying with tissue paper. Then they were surface dried with blotting paper. Their fresh and dry weights were recorded with top load electrical balance. Root and shoot samples were oven dried at 70°C till constant dry weight and their dry weights were measured.

Statistical Analysis

All attribute data underwent a two-way analysis of variance (ANOVA) using statistical software, specifically the COSTAT computer package V6.303 (Cohort Software, Berkeley, USA).

RESULTS

The current research focuses on impact of salinity stress on some tolerant and sensitive lines mung bean. The result showed that fresh and dry biomass (shoot & root) of all the lines of *Vigna radiata* has significantly ($P<0.001$) decreased by applying 120 mM NaCl as compared to plants without any salt treatment which showed normal growth and their biomass was high. Lines showed significant difference with each other in their fresh shoot ($P<0.001$) and root ($P<0.01$) biomass. No growth was observed at 120 mM NaCl level in the plants of all five lines as compared to control plants. While the lines i-e 07006MB and 08009MB showed slight increase in their fresh and dry shoot biomass under 120mM NaCl. Similarly, root fresh biomass was slightly increased in 07006MB and 14005MB, but dry root biomass was observed maximum in line 14005MB as compared to other lines under 120 mM NaCl as shown in Figure 1 & Table 1.

DISCUSSION

Plants interact with the environment and any conditions that exceed the limits where plants normally function may impose a stress and limit plant growth and development [7]. Unlike other organisms that can avoid and protect themselves from stressful condition through movement, plants have developed different tolerance or adaptation mechanisms that allow to defend themselves against stressors and support their growth and development [8,9]. Global warming and the ongoing climate change have intensified the incidences of abiotic stressfull conditions for agricultural crops and vegetables in particular which are more susceptible to environmental stressors [1,2,6,5,8-14]. Therefore, there is an urgent need to adopt new or modify the existing cultural practices in order to break out from the vicious circle between modern farming systems and climate change and tolerant or resistant species are ideal for this [1,2,8,13,14]. Soil salinity is distinguished in primary and a secondary salinity. The primary one is a consequence of natural processes of rock disintegration that release soluble salts, such as chlorides of sodium, calcium and magnesium, sulphates and carbonates into water, which are deposited in soil solution through the wind and rain. The most easily transported salt in this process is sodium chloride. On the other hand, secondary salinity is the result of human activities, such as the replacement of perennial crops with annual crops, the use of irrigation water with high concentration in salts and the irrational use of

Table 1: ANOVA (analysis of variance) for the data of shoot and root fresh, dry weight of nine lines grown under control and various levels of salt (120 mM NaCl) in petri dishes.

Source of Variance	df	SFW	RFW	SDW	RDW
Salinity	1	2.622***	0.0011***	0.0042***	20000*
Varieties	8	3.650***	0.0066**	0.0136*	2.638ns
Salinity x Variety	8	0.141***	0.0048ns	0.0022ns	3.750ns
Error	54	0.048	0.0021	0.0015	3.981
Total	71				

***, **, * = significant at 0.05, 0.01 and 0.001 levels respectively, ns = non-signifiant

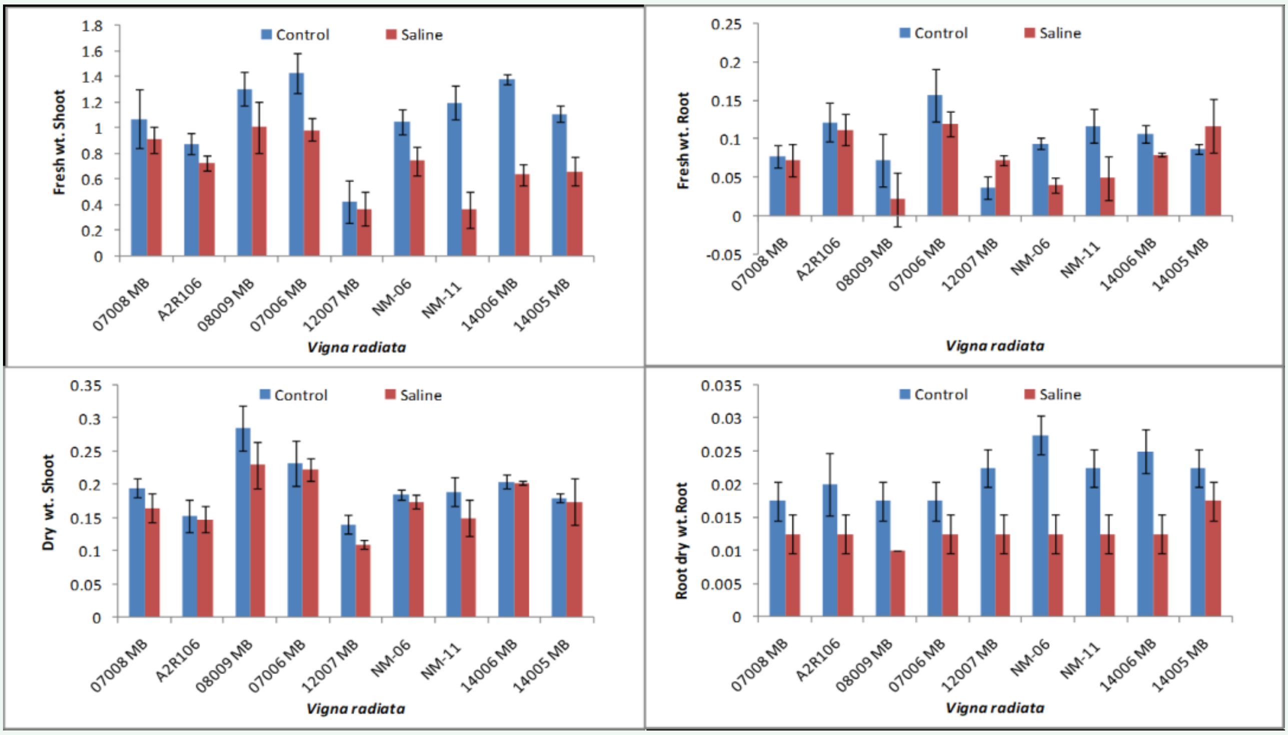

Figure 1 Shoot & root fresh, dry weight gplant-1 of nine Vigna radiata lines grown under control and various levels of salt (120 mM NaCl) in petri dishes.

chemical fertilizers which altogether increase soil salinity [15]. About 20% of cultivated land worldwide (1500 million hectares) is salt-affected, while in the Mediterranean basin, water quality has already become a limiting factor for agriculture, due to the excessive use of salt water in coastal areas [11]. The current research focuses on impact of salinity stress on growth attributes of some salt-sensitive and tolerant lines of mung bean. The current studies resulted that shoot, and root fresh, biomass of all mung bean lines was gradually decreased by applying 120 mM NaCl stress as compared to control plants. High levels of salts create a noxious effect on the whole plant which has resulted in a reduction of growth and productivity. Ahmed S, et al. [16] have reported similar findings in lettuce where salinity stress decreased the shoot and root biomass.

CONCLUSION

The overall results declared that the lines i-e 07006MB and 08009MB showed slight increase in their fresh and dry shoot biomass under 120mM NaCl. Similarly, root fresh biomass was slightly increased in 07006MB and 14005MB, but dry root biomass was observed maximum in line 14005MB as compared to other lines under 120 mM NaCl. The lines could be used for further investigation.

Author's Contribution

Study was designed by SA and FS, Experiments were performed by AS, SS, NS and analysed by MN, IJ, and RA. Manuscript was written by IM, FS and edited by SA.

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