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Research Article

Impact of Various Levels of Salinity Stress on Growth Attributes of Some Salt-Sensitive and Tolerant Varieties of Mung Bean

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- Salinity
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Abstract

Salinity stress poses a significant threat to crop productivity, and understanding the mechanisms of ion uptake and distribution in different cultivars is crucial for developing salt-tolerant varieties. This study investigates the patterns of ion uptake and distribution in salt-sensitive and salt-tolerant cultivars of Vigna radiata, commonly known as mung bean. Hydroponic experiments were conducted under controlled conditions to assess the responses of two contrasting cultivars to varying salt concentrations. The study reveals distinct differences in the ion uptake and distribution between salt-sensitive and salt-tolerant cultivars of V. radiata. Salt-sensitive cultivars exhibited increased sodium (Na+) accumulation in both roots and shoots under saline conditions, leading to disrupted ion homeostasis. In contrast, salt-tolerant cultivars demonstrated efficient ion regulation mechanisms, with a higher capacity for potassium (K+) retention and a lower Na+ to K+ ratio. The study also shed light on the involvement of ion transporters and channels in facilitating differential ion accumulation, highlighting the molecular mechanisms contributing to salt tolerance in Vigna radiata. 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 intricate relationship between ion uptake and distribution in Vigna radiata varieties with varying salt tolerance. 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 [1]. 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 (FAO, 2005). 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 [2]. 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 (WRPI & IWASRI, 2005). 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. 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 [3]. Maize belonging to Poaceae family of C_4 type is reported as salt susceptible [4]. Salt anxiety emphatically impacts plant development and advancement, particularly maize plants, which are accounted for as salt delicate species. A primary response in salt stressed plants is a decrease in plant water potential, resulting in decrease water use efficiency, leading to the overall toxic damages and yield reduction [5]. Salt stress is also found to impair the cellular electron transport within the different sub cellular compartments and results in generation of ROS [6]. 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 [6]. Mung bean is botanically recognized as Vigna radiata. Mung bean is commonly known as green gram and is widely distributed Asiatic spy. 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 spy are found in Africa The primary objectives of this study on ion uptake and distribution patterns in salt-sensitive and tolerant varieties of Vigna radiata are multifaceted. Firstly, we aim to discern the distinctive mechanisms by which salt-sensitive and salt-tolerant cultivars of Vigna radiata regulate ion uptake under saline conditions. This investigation seeks to unravel the specific patterns of sodium (Na^+) and potassium (K^+) distribution within the roots, stems, and leaves of these cultivars, shedding light on their differential responses to salinity stress.

RESEARCH METHODOLOGY

The present study was conducted to investigate the influence of salinity on the ion distribution in different cultivars 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 varieties 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 > 60 mm NaCl and 120 mm NaCl). To mitigate evaporate-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 70^0C till constant dry weight and their dry weights were measured.

Statistical Analysis

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

RESULTS

Fresh Weights (g/plant)

Fresh weight of all the nine varieties of Vigna radiata decreased gradually with increasing levels of salt concentration as compared to plants without any salt treatment. While at 100 mm NaCl and above fresh weight of shoot and root per plant drastically decreased. No growth was observed at 120 mm NaCl level in all five varieties at the first and second harvest. A slight increase in root and shoot fresh weight was observed with slight increase in salinity. In one cultivar named A2R106 fresh biomass of plant slightly increased at 50m M NaCl as compared to 20 mm NaCl level. At second harvest non-significant differences between all the treatments for fresh weights of shoot per plant were noted which at 120 mm NaCl drastically decreased (Figure 1,Table 1).

Dry Weights (g/plant)

Dry weights of shoot and root per plant decreased with increasing salinity level and the differences between them were significant for various treatments. Shows that dry weights of whole plant biomass were slightly increased with increase in salt concentration at all two harvests. Dry weights of all cultivars drastically decreased at higher level of NaCl. No plants survived at 120 mm of NaCl (Figure 1,Table 1).

Table 1: ANOVA (Analysis of Variance) for the data of shoot and root fresh, dry weight of nine cultivars grown in Petri dishes for screening, one week by using full strength Hoagland nutrient solution.

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 = nonsignificant

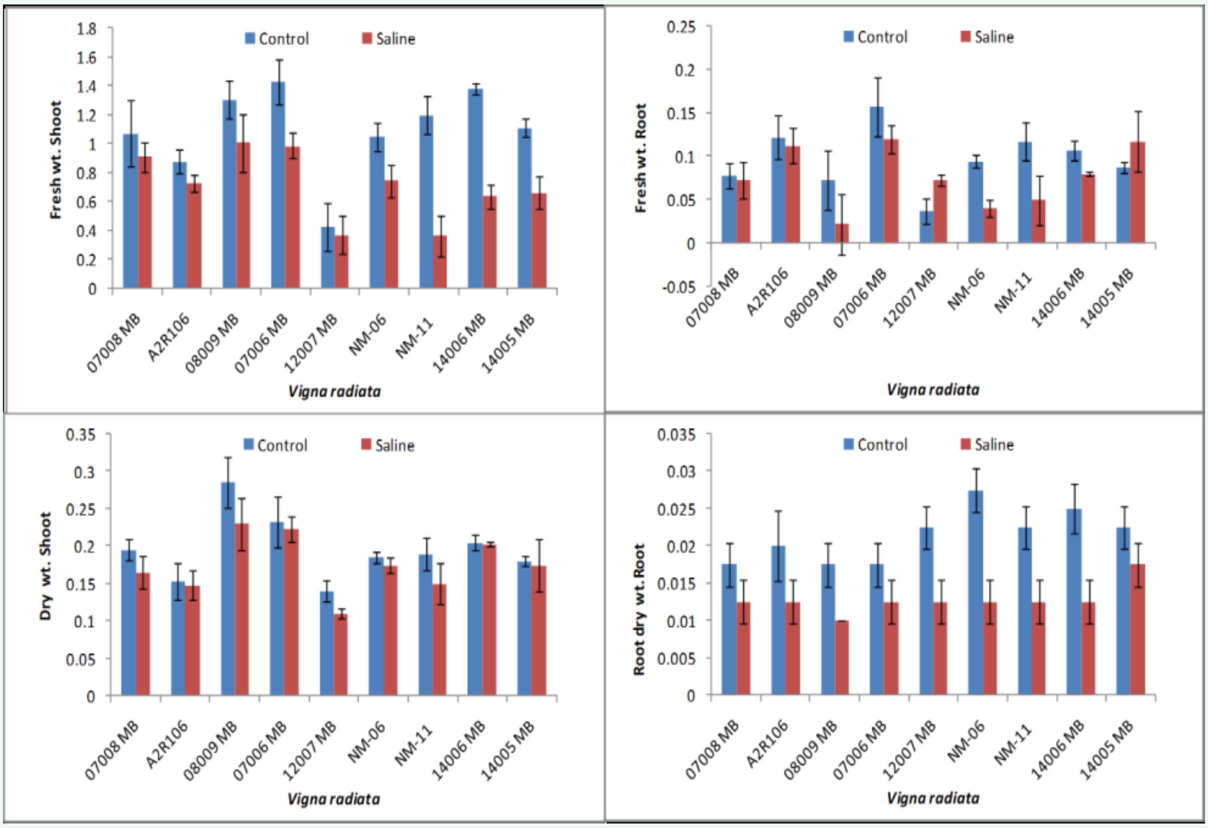

Figure 1 Shoot fresh weight of nine Vigna radiate cultivars grown under control and various levels of salt (60 and 120 mm) in petri dishes.

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