RESEARCH ARTICLE

Assessment of Salinity Tolerance in Different Genotypes of Pearl Millet *(Pennisetum glaucum (L.)R .Br.)*

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ABSTRACT

This study assessed salinity tolerance in 11 pearl millet genotypes at germination and seedling stages under varying salt concentrations. Results showed a reduction in germination percentage, plumule and radicle lengths, with more significant decreases at higher salinity levels (75mM, 100mM). Despite poor germination, dry weight increased with salt concentration, indicating salt accumulation. Radicle length increased up to 25mM, suggesting plant adaptability to abiotic stresses. Under control conditions, CO 10 and CO (Cu) 9 exhibited the highest germination, while PT 6476 showed the least at 100mM salinity. ICMB 10444 had the maximum plumule length, and ICMB 98222 had the minimum. CO Cu 9 showed the highest radicle length under control, while Kizhilikuppam had the highest at 100 mM salinity. ICMB 15088 had the highest dry weight under control, and CO H 10 had the highest at 100 mM salinity. All genotypes were affected by NaCl stress, reducing seed germination, seedling growth, and nutrient uptake. COH10 showed the least impact, indicating higher genetic potential for salinity tolerance.

Keywords: *Pearl millet genotypes; Salinity tolerance; Germination; Seedling stage; NaCl stress; Dry weight.*

INTRODUCTION

Salinity poses a severe threat to crop production, especially in dry and semi-arid regions worldwide. Soluble salts in soils elevate soil salinity, restricting plant growth by binding water more firmly than plants can extract. Different crops exhibit varying responses to salinity, with most being sensitive, leading to slower growth rates, reduced tillering, branching, and reproductive growth over several months.

India faces substantial salinity challenges, affecting over 6.7 million hectares, including saline, alkali, and coastal soils. Gujarat and Uttar Pradesh bear a significant burden, impacting more than 50% of their lands. The Indo-Gangetic plain, Bihar, West Bengal, Delhi, Haryana, Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, and peninsular states face ecological concerns due to salt-affected soils.

Millets, known as Nutri-Cereals, emerge as vital crops offering abundant nutrition and health benefits. Pearl millet, a standout, contains substantial iron (4-8 mg/100g), aiding in managing anemia. With twice the protein of milk, millets, especially ragi (finger millet), boast the highest calcium content (364 mg/100g), three times more than milk. Rich in dietary fiber, millets promote digestion, prevent constipation, and possess pre-biotic properties beneficial for gut health.

India is the leading producers of millets Madhya Pradesh, Tamil Nadu, Andhra Pradesh, and Uttarakhand being top-producing states. Millets play a crucial role in India's agricultural landscape.

Salinity Management and Biomass for Renewable Energy:

In dry and semi-arid tropics, managing salinity through soil reclamation or improved irrigation is expensive for underdeveloped nations. Crop improvement emerges as a cost-effective, long-term alternative. Pearl millet, a staple in dry regions, shows promise in saline areas, supporting increased production.

As global energy consumption rises, the adverse environmental effects of non-renewable fuels become evident. Biomass stands out as the renewable energy solution, with millets contributing to biofuel production. Pearl millet, with its superior chemical composition, presents an excellent option for biofuel production due to its high cellulose and hemicelluloses content.

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Objective of the Study:

Given the significance of pearl millet, there is a pressing need to expand cultivation into problem soils like saline areas. This study aims to identify salt-tolerant genotypes, screen them under varying saline concentrations, and pinpoint tolerant genotypes during the germination phase. The findings hold the potential to enhance cultivation in saline-prone areas and guide the development of salt-tolerant pearl millet varieties.

Study Objectives:

The study aims to identify salinity-tolerant pearl millet genotypes for increased cultivation in saline areas. Specific goals include genotype collection, screening under different saline concentrations, and identifying tolerant genotypes during germination.

MATERIAL AND METHODS

Eleven pearl millet varieties (PT 6476, CO 10, CO H 10, 86 M 38, CO CU 9, KIZHILIKUPPAM, PT 6067, PT 6710, ICMB 10444, ICMB 15088, ICMB 98222) were sourced from the Millets Research Centre, TNAU, Coimbatore.

Characteristics of Pearl Millet Varieties:

- **CO 10:** Tall, strong tillering, quick growth, matures in 70-80 days, 230-250 cm height, high grain production, resistant to downy mildew and shoot flies.
- **CO(Cu)9:** Tall and erect, fast growth, matures in 70-80 days, 250-280 cm height, high grain output, resistant to downy mildew and shoot flies.
- **ICMB 15088:** Early maturity in 70-80 days, variable resistance to pests, medium-sized grains suitable for human and animal consumption.

Salinity Conditions:

Artificial salinity was induced using NaCl at concentrations of 0mM, 25mM, 50mM, 75mM, and 100mM.

Screening at Germination Phase:

NaCl was used at different concentrations (0mM, 25mM, 50mM, 75mM, 100mM) to create salinity conditions. The experiment, conducted in Petri dishes at the Department of Plant Breeding and Genetics, used 11 pearl millet genotypes, with each treatment replicated twice in a factorial randomized block design. Observations recorded eight days after sowing included germination percentage, plumule and radicle lengths, plumule-radicle ratio, and fresh and dry weights.

Observations Recorded (8 Days After Sowing):

- Germination (%)
- Plumule Length (cm)
- Radicle Length (cm)
- Plumule-Radicle Ratio
- Fresh Weight (gm)
- Dry Weight (gm)

Germination Percentage Calculation:

$$GP = \frac{\text{Seeds germinated}}{\text{Total seeds}} \times 100$$

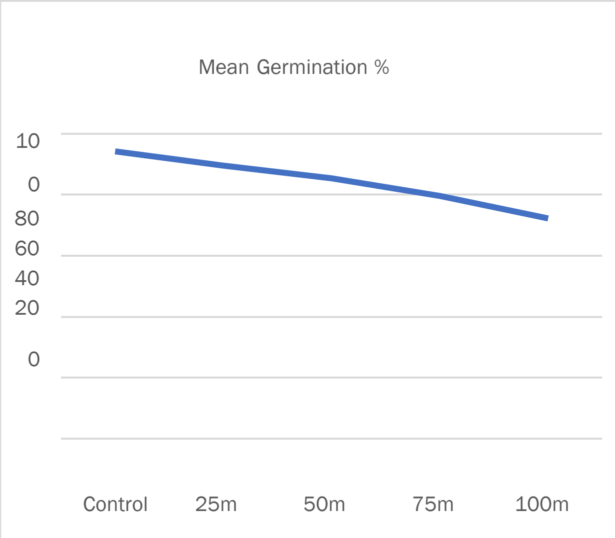
Statistical Analysis:

Two-way ANOVA was employed to analyse the data, with factors A and B representing levels of interest for the experiment. The model is a fixed-effects model, and the resulting ANOVA table includes factors A, B, their interaction (AB), and error (SSE).

RESULTS AND DISCUSSION

The study focused on evaluating the salt tolerance of 11 pearl millet varieties during the seedling stage. Salinity conditions significantly impacted seed germination, seedling growth, and nutrient uptake across all varieties. COH10 exhibited the least susceptibility, followed by CO(Cu)9, CO10, and ICMB 98222 at the highest salinity level (100 mM), indicating their higher genetic potential for salinity tolerance. Conversely, Kizhilikuppam, ICMB 15088, and ICMB 10444 were identified as highly susceptible genotypes.

The observed reduction in seed germination, seedling growth, and dry matter yields under NaCl stress aligns with previous findings in sorghum and pearl millet. The differential responses among genotypes highlight the importance of genetic factors in salt tolerance. Notably, the increase in dry matter weight with salinity suggests ion accumulation, with COH10 demonstrating resistance to ion toxicity. The study underscores the need for further field research to validate and implement the identified salt-tolerant genotypes in saline-prone areas for developing resilient pearl millet varieties.



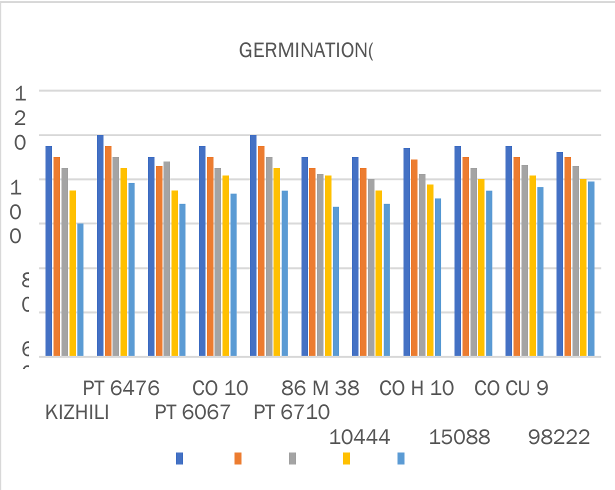
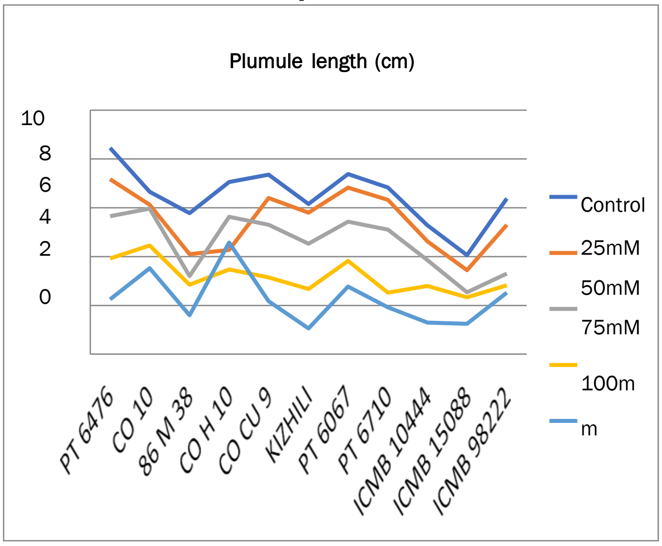


Figure .1 Mean percentage of germination for pearl millet genotypes at different levels of salinity level



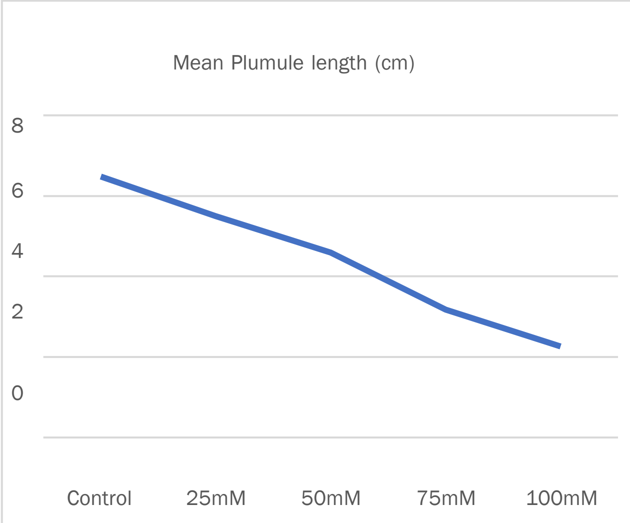
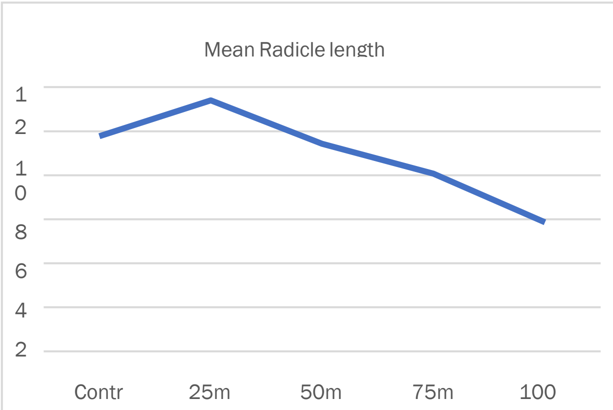


Fig. 2. Mean plumule length (cm) for pearl millet genotypes at different salinity level



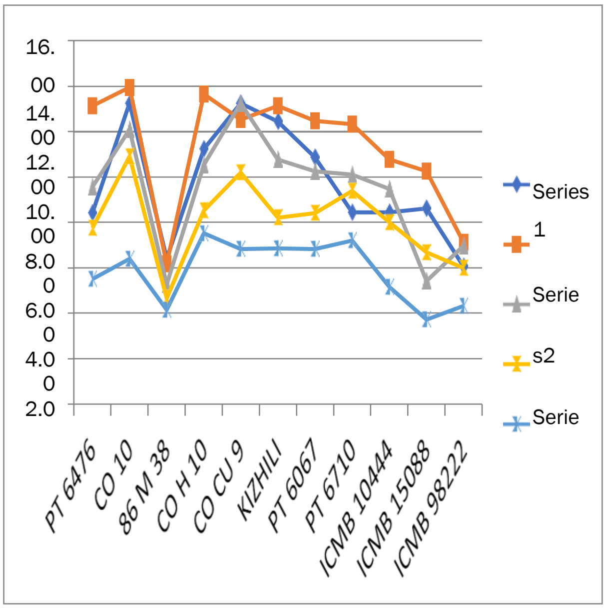
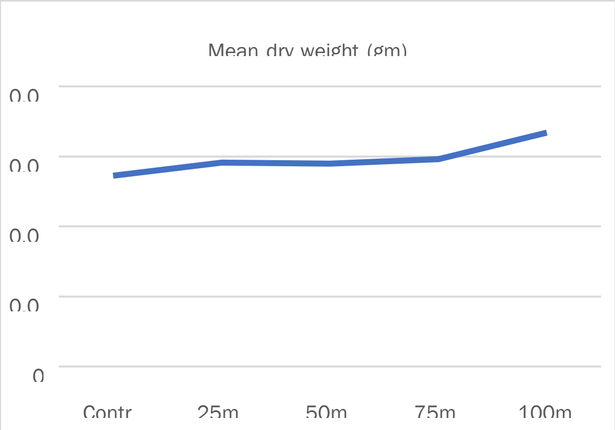


Fig. 3. Mean Radicle length (cm) for pearl millet genotypes at different levels of salinity level



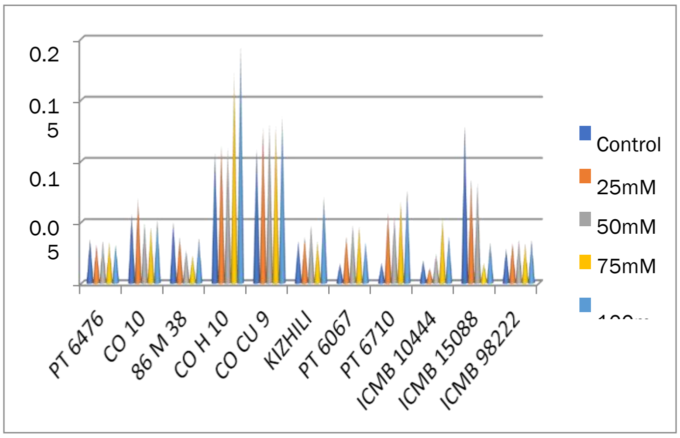
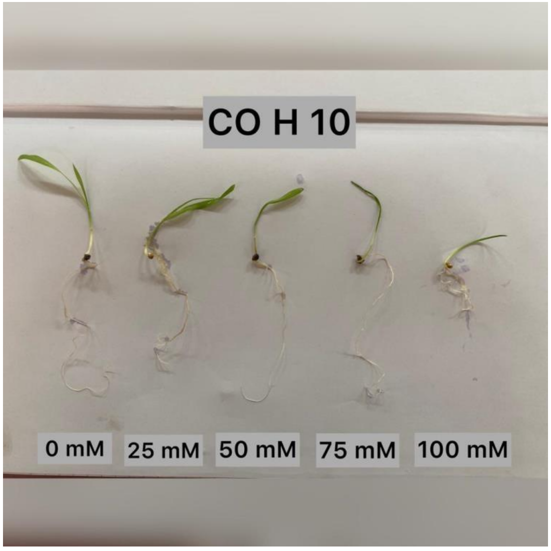
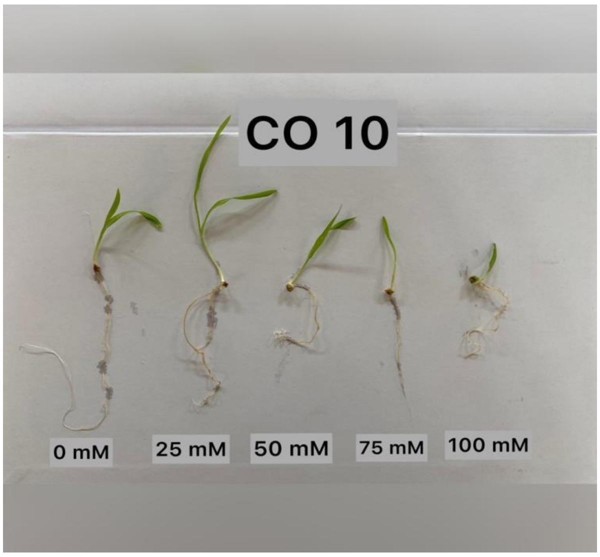


Figure 4 Mean Dry Weight (gm) for pearl millet genotypes at different levels of salinity level



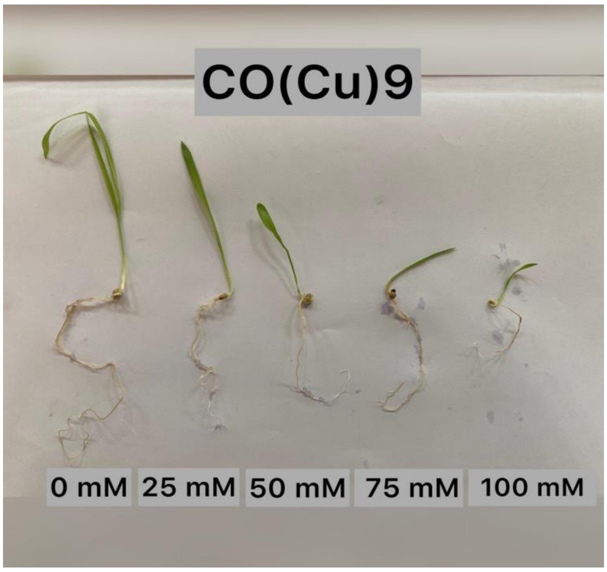
Seedling evaluation of CO H 10 pearl millet genotype at different levels of saltconcentration



Seedling evaluation of CO 10 pearl millet genotype at different levels of salt concentration

Seedling evaluation of Kizhilikuppam pearl millet genotype at different levelsof salt concentration

Seedling evaluation of CO Cu 9 pearl millet genotype at different levels of saltconcentration



CONCLUSION

NaCl stress reduced seed germination, seedling growth, dry matter yields and nutrients uptake by all the eleven pearl millet varieties, but COH10 was least affected compare to other varieties followed by CO(Cu)9 and CO10 and ICMB 98222 under the highest salinity level (100 mM), thus demonstrating its higher genetic potential for salinity tolerance. The genotypes Kizhilikuppam, ICMB 15088 and ICMB 10444 are highly susceptible genotypes. However, further research should be conducted under field conditions in order to authenticate these findings. The tolerant genotypes can be recommended in the saline susceptible area and can be utilized for further development of salt tolerant varieties.

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