Screening Field Grown Pearl Millet (*Pennisetum glaucum* L.) Genotypes For Salinity Tolerance in the North of Tunisia

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Abstract. The focus of this study is to compare salt stress response among pearl millet genotypes, based on agronomical traits. A field experimental complete randomized design (CRD) was conducted during the summer-winter season (July -December) of 2010, at the Agricultural Experimental Station of Nabeul. Nine pearl millet *Pennisetum glaucum* L genotypes (IP 22269; IP 13151; MC 94C2; IP 19612; SVDANPOL III; ICMV 1550; IP 7704; HHVBCTAB2; IP 19586) were irrigated with saline water (8.57 dS.m⁻¹ EC). Plant height, biomass accumulation and morphological measures of clusters (weight, length, diameter) were determined. Based on plant height and fresh biomass accumulation, we could classify the genotype IP22269 as more tolerant to salinity, while MC94C2 as sensitive genotype. MC94C2 was once more identified as sensitive genotype, based on less clusters weight. Highest values of clusters weight and diameter were recorded for IP19586 and IP19612. Thus, a noticeable variability in salt tolerance was observed among studied genotypes.

1. Introduction
Pearl millet is a potential livestock crop grown in saline affected areas, where high salinity levels prevent crop production. It is categorized as glycophyte and as an average salt threshold of approximately 4000–6000 ppm [1]. Considerable variation for salt tolerance has been reported within pearl millet genotypes [2]. The short life cycle of this plant has made it more important as a second fodder crop after wheat or barley [3]. It has been indicated that pearl millet is more tolerant to salt stress than maize, wheat, and rice, with high genotypic variation in salt tolerance [4]. Several investigations in the literature revealed that Pearl millet and its related species are pretty tolerant to salinity [5, 6, 7, 8, 9] and provide an alternative for identifying crops that can be cultivated effectively in saline soils and/or irrigated with brackish water [10]. Others research, however, has established that salinity has a negative impact on the morphology, anatomy, and physiology of pearl millet [8]. In this setting, [11] supposed that the crop reacts to salt stress in two stages: (1) the quick osmotic phase, which restricts the growth of young leaves, and (2) the slow ion phase, which speeds up the aging of mature leaves. Overall, it appears that, while different factors have been linked to tolerance, variation...
in whole plant reactivity to salinity has been recommended to give the best way of initial isolation of salinity resistant genotypes. Pearl millet has been shown to have significant genotypic heterogeneity in salt sensitivity in terms of whole plant response. Furthermore, the availability of high levels of tolerance in other Pennisetum species [12] and within P. glaucum [13] provides a scope for understanding the traits related to tolerance and integrating these tolerant crop species/genotypes into appropriate management programs to improve the productivity of saline water and salt-affected soils. This suggest that pearl millet owns rich genetic resources for improving productivity under saline conditions. However, studies identifying salt-tolerant genotypes and the exact mechanisms associated with salt tolerance are scarce [14, 15].

The effect of salinity upon the distribution, growth and productivity of staple food crops is potentially severe [16]. Nearly 20% of the world’s cultivated land and half of irrigated areas are affected by salinity [17]. Salinity has several effects on plants including reduced growth, limited yield, ionic stress, restraint geographical distribution etc… [18]. Salt stress impacts are particularly severe in arid and semiarid areas [19]. In Tunisia, water resources, originated from wetlands, as low areas in the landscape, are increasingly exposed to salinity [20]. In such a setting, the development of sustainable salt-tolerant agricultural production systems that are less resource-demanding and make use of marginal lands and salt water supplies is critical. As a result, assessing the response of pearl millet genotypes that differ in salt tolerance is an essential stage in the selection of salt tolerant plants to ensure improved cultivation durability. Selecting salt-tolerant accessions of staple crops is an efficient strategy for achieving acceptable yields in moderately salty environments. The evaluation of salt-tolerant genotypes under field conditions is very difficult, owing to high climatic and edaphic conditions variability [21]. For this reason, most screening experiments are conducted under controlled conditions [22, 23]. Characterization of salt stress response of field grown pearl millet accessions could be an effective study contributing for better selection of salt adapted plants. In the present study, nine genotypes of pearl millet *Pennisetum Glaucum* L were used with the aim to evaluate their response to salt stress under local climatic conditions of the north of Tunisia.

2. Materials and Methods

2.1. Plant material and experimental design

Plant material composed of nine genotypes of Pearl millet (*Pennisetum Glaucum* L): IP 22269; IP 13151; MC 94C2; IP 19612; SVDANPOL III; ICMV 1550; IP 7704; HHVBCTAB2; IP 19586. Genotypes were acquired from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Hyderabad, India. Table 1 presented supplementary details about characteristics, origins, and genetic background of genotypes used in the study.

A field drip irrigation experiment was carried out at the Agricultural Experimental Station of Nabeul during the summer-winter season (July -December) of 2010. This region enjoys a Mediterranean climate with 470 mm annual rainfall and 1370 mm annual evapotranspiration. The field experiment was carried out using a completely randomized design (CRD) with three replicates (see Figure 1), and the genotype was the major factor, with 9 levels matching to the nine pearl millet genotypes tested.

The studied genotypes were planted in elementary parcels with an area of 30 m² (3m x 10m) each one. The sowing was done manually at 17 July 2010, with spacing of 20 cm on the line and a density of about 80000 plants ha⁻¹. The emergence was noticed at 20/7/2010.
Table 1. Characteristics, origins, and genetic background of 9 pearl millet genotypes (IP 22269, IP13151, MC94C2, IP19612, SVDANPOLIII, ICVMV1550, IP7704, HHVBCTAB2 and IP19586).

| Genotype identifier | Biological status | Acquisition date (YYYY/MM) | Pedigree / origin | Latitude / Longitude of collecting site |
|---------------------|-------------------|----------------------------|-------------------|------------------------------------------|
| IP 22269            | Breeding/research material | 1997/01                   | India             | 17.512414 / 78.275371                    |
| IP 13151            | Traditional cultivar/Landrace | 1986/05                   | Niger             | 13.510001 / 6.849999                     |
| MC 94C2             | Improved cultivar | -                          | MC94C2 -S1 -3-1-2-3-2 (J.A.U.Jamnagar- India) | -                                     |
| IP 19612            | Traditional cultivar/Landrace | 1993/03                   | Niger             | 17.25 / 8.100001                        |
| SVDANPOL III        | -                  | -                          | -                 | -                                        |
| ICMV 1550           | Landrace           | -                          | Open pollinated variety introduced from ICRISAT by ARC, Sudan. | -                                     |
| IP 7704             | Traditional cultivar/Landrace | 1983/04                   | India             | 19.379999 / 74.650001                    |
| HHVBCTAB2           | -                  | -                          | -                 | -                                        |
| IP 19586            | Traditional cultivar/Landrace | 1993/03                   | Niger             | 17.520001 / 8.649999                     |

Figure 1. Layout of the field experimental complete randomized design (CRD) of nine genotypes of Pearl millet (Pennisetum Glaucum L) with three replicates (IP 22269, IP13151, MC94C2, IP19612,
The pearl millet plants were irrigated using a drip irrigation system with built-in drip lines and emitter spacing of 20 cm. Crop water requirement was calculated according to the formula: ETM = Kc x ETP where ETP is the Maximum evapotranspiration and Kc values depend on pearl millet developmental stages [15]. Chemical soil and irrigation water characteristics are given in table 3 and table 4, respectively.

Table 2. Chemical characteristics of soil

| Depth (cm) | pH  | EC (mS cm\(^{-1}\)) | Cl\(^{-}\) (meq l\(^{-1}\)) | SO\(_4^{2-}\) (meq l\(^{-1}\)) | HCO\(_3^{-}\) (meq l\(^{-1}\)) | Ca\(^{2+}\) (meq l\(^{-1}\)) | Mg\(^{2+}\) (meq l\(^{-1}\)) | K\(^{+}\) (meq l\(^{-1}\)) | Na\(^{+}\) (meq l\(^{-1}\)) |
|-----------|-----|--------------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 0 – 20    | 7.6 | 0.87               | 1.54            | 1.78           | 2.81            | 4.49            | 1.81            | 1.43            | 1.66            |
| 20 – 40   | 7.7 | 0.154              | 1.778           | 0.34           | 0.21            | 0.66            | 0.33            | 0.38            | 0.51            |
| 40 – 60   | 7.7 | 0.135              | 1.559           | 0.30           | 0.19            | 0.58            | 0.29            | 0.33            | 0.45            |

Notes: Results taken before the beginning of the experiment each value is an average of three replicates.

Table 3. Chemical characteristics of used irrigation water

| pH | EC (dS.m\(^{-1}\)) | Na\(^{+}\) (meq l\(^{-1}\)) | Cl\(^{-}\) (meq l\(^{-1}\)) | K\(^{+}\) (meq l\(^{-1}\)) | Ca\(^{2+}\) (meq l\(^{-1}\)) | Mg\(^{2+}\) (meq l\(^{-1}\)) | SAR (meq l\(^{-1}\)) |
|----|-------------------|-----------------|----------------|-----------------|-----------------|-----------------|----------------|
| 7.45 | 8.57         | 35.65           | 34.21          | 7.73             | 4.83            | 14.26            |

Notes: Each value is an average of five replicates; The sodium absorption ration (SAR) was calculated as the ratio between Na\(^{+}\) concentration and Ca\(^{2+}\) + Mg\(^{2+}\) concentrations (SAR = [CNa] / [√(CCa + CMg)/2]).

2.2. Measurements

Measurements of plant height, clusters weight, length and diameter were recorded at 60 days after emergence while fresh biomass per area (m\(^2\)) was determined at maturity.

2.3. Statistical analysis

The experiment was implemented under a design of a completely randomized design (CRD) with three replicates. Statistical analyses were made with SPSS for Windows 21.0 (SPSS, Chicago, IL, USA). All parameters were measured for at least 15 plants (n = 15). Data were subjected to analysis of variance (ANOVA) with the genotype is the main factor. Comparisons between mean values were made by Duncan’s multiple-range test and they were considered significantly different with p-values < 0.05. PCA analysis was carried out to characterize the genotypes distribution according to studied traits.

3. Results and Discussion

3.1. Plant height and biomass production

Changes in plant height are presented in figure 2. Among the nine studied Pearl Millet genotypes IP22269, IP13151, MC94C2, IP19612, SVDANPOLIII, ICVMV1550, IP7704, HHVBCTAB2, IP19586, the highest and the lowest height were registered respectively by IP22269 (2.3 m) and MC94C2 (1.2 m). This result was in agreement with [16] who noticed a variability of shoot length across foxtail millet accessions. A previous study of [7] indicated that pearl millet shoot growth trait may not be used alone as criteria for selection as there was no relation to biomass productivity at anthesis. Contrarily, [24] found that pearl millet length is affected negatively by salinity and was in correlation
with reduced leaf growth. [18] indicated that the most efficient parameters for evaluation of seedling salt tolerance in broomcorn millet are aboveground and belowground biomass. From results of biomass accumulation (figure 3), the assessed genotypes can be classified into four groups. The first group, with the highest biomass production, corresponds to the genotype IP22269. It had approximately 5 kg m$^{-2}$. The second group includes the genotype IP 7704, for which the fresh biomass production decreased to 4 kg m$^{-2}$. In the third group, we found the two genotypes IP19612 and IP19586 with 25% lesser fresh biomass than IP7704. Finally, the fourth group (HHVBCTAB2 and MC94C2) includes genotypes with biomass values in the range 2.4 - 1.6 kg m$^{-2}$. According to [7], the ability of plant to maintain its biomass under stressful environment reflects its tolerance level to such stress. Thus, we can interpret that IP22269 genotype was more tolerant to salinity. This author also reported that the tolerance of pearl millet to salinity is highly dependent on the ability to maintain the shoot K$^+$/Na$^+$ and Ca$^{2+}$/Na$^+$ ratio. The overall mean of K$^+$/Na$^+$ ratio was about 1.7 under saline conditions, substantially lower than that under the non-saline control (about 6.6).

The reaction of the plant examined to increased salinity is complex, although cultivars/genotypes clearly differ. Their tolerance ranking, on the other hand, changes according on the character being evaluated. Nonetheless, some feature combinations may serve as helpful selection criteria for improving salt tolerance by leveraging inter- and intra-specific variation in response to high salinity. To assess a plant's ability to withstand abiotic stress, biomass production is utilized as a functional parameter [25]. In fact, some authors [5, 6, 25] believed that the diversity in whole-plant biomass responses to salinity was the best way to select salinity-tolerant genotypes before evaluating them on the basis of specific traits. These authors reported that growth is the final morphological representation of numerous metabolic activities taking place in the plant, and so it more clearly reflected the level of tolerance. This was similar to the findings of Bessa et al. [26], who assessed the responses of caatinga species to salt stress and observed differences between the effects of salinity on physiological and biomass criteria of the species, demonstrating that only the latter allowed the species' degree of tolerance to be identified.

Figure 2. Changes in plant height of nine Pearl Millet genotypes (IP 22269, IP13151, MC94C2, IP19612, SVDANPOLIII, ICVMV1550, IP7704, HHVBCTAB2 and IP19586)
6

*Histograms followed by the same letter indicate no significant differences (P≤0.05) according to Duncan test

Figure 3. Changes of fresh biomass accumulation in Pearl Millet genotypes (IP 22269, IP13151, MC94C2, IP19612, SVDANPOLIII, ICVMV1550, IP7704, HHVBCTAB2 and IP19586) *Histograms followed by the same letter indicate no significant differences (P≤0.05) according to Duncan test

3.2. Morphological characteristics of clusters
Figure 4 shows variation in cluster length, diameter, and weight. Plants of the genotype IP7704 and P13151 had the highest cluster length of around 29.2 cm. Lowest cluster length values were registered by IP19586 and IP19612 and was 14.5 cm. Regarding cluster diameter, the highest value (29.7 mm) was observed for the genotype IP19612, while least value was noticed for IP7704 genotype. Generally, the cluster diameter varied a little among genotypes compared to length and weight. We perceived that long clusters do not usually associate to thick ones. Meanwhile IP13151 had both high cluster weight (13.58 g) and length. On the other hand, MC94C2 had the lowest cluster weight (5.3 g). The difference between genotypes may be linked to distinct genetic capabilities. In fact, salinity may cause physical damage in the emerged radicle and plumule limiting clusters production and plant height [28]. Thus, based on clusters measures we can assemble the genotypes of high clusters length (IP7704, SVDANPOLIII and P13151) and genotypes with high clusters diameter and weight (IP19612, P13151) into less salt sensitive genotypes. Generally, less clusters weight reflects the less yielding capacity. This may be due to improper development of leaves under salt stress which in turn reduced net assimilates, biomass production and yield [24, 28].
Figure 4. Variation of Clusters length, Clusters diameter and Clusters weight between Pearl Millet genotypes (IP 22269, IP13151, MC94C2, IP19612, SVDANPOLIII, ICVMV1550, IP7704, HHVBCTAB2 and IP19586).

*Histograms followed by the same letter indicate no significant differences (P≤0.05) according to Duncan test.
### 3.3. Inter-parametric relations

Correlation between agronomic attributes (Table 5) revealed that fresh biomass production (BP) was significantly correlated to plant height (PH) augment. Moreover, clusters weight (CW) evolution was significantly associated to changes in clusters diameter (CD), although, the clusters diameter (CD) was negatively correlated to clusters length (CL). This may indicate that the diameter and weight of clusters varied independently, they only account for genotypic differences.

Table 4. Correlation coefficients between agronomic parameters: Biomass production (BP), Plant length (PL), Cluster length (CL), Cluster diameter (CD) and Cluster weight (CW)

|       | PH   | CL   | CD   | CW   | BP   |
|-------|------|------|------|------|------|
| PH    | 1    |      |      |      |      |
| CL    | -0.19| 1    |      |      |      |
| CD    | 0.01 | -0.61*| 1    |      |      |
| CW    | 0.30 | 0.23 | 0.57*| 1    |      |
| BP    | 0.67*| -0.12| -0.03| 0.00 | 1    |

* Correlation is significant at the 0.05 level (2-tailed)

Additional analysis with principal component analysis (PCA) aiming to identify traits distribution according to studied genotypes are presented in Figures 5 and 6. Globally in PCA analysis, factors or parameters with roughly comparable influence on defining a direction are connected and have roughly analogous numeric weights. However, negatively associated characteristics will display diagonally opposite one another. Figure 4 demonstrated that in this context, plant length (PL) and biomass production (BP) are closely associated and have about the same weight value in PCA. Cluster weight (CW) and Cluster diameter (CD) exhibit nearly comparable behavior (CD). Whereas there is a significant stigma between Cluster weight (CW) and Cluster length (CL), they appear diagonally opposite each other in the loading plot.

The two PCA axes account for around 70% of total variability (figure 5). The first principal component expressed 40% of the inertia and is defined by variables describing the morphological characters of the cluster: Cluster diameter (CD) and Cluster weight (CW) sited in the lower right square. The second PCA axe accounts for 30% of the total variability and is defined mainly by the length of plants (PL) and vegetative biomass production (BP) sited in the higher right square.

The figure 6 indicates the dispersion of Pearl Millet genotypes. Results showed that IP22269 genotype had the highest plant length and biomass production. In addition, IP7704 and SVDANPOLIII constitute a second group having elevated cluster length. The genotypes IP19586 and IP19612 had high cluster diameter and cluster weight values. The other genotypes outside the above-mentioned groups has a specific behavior. Overall, it can be committed that 8.57 dS.m$^{-1}$ salinity level was not toxic for all studied pearl millet genotypes. In this line, several previous studies [6, 7, 10, 28] reported that pearl millet and its related species are classified as fairly tolerant to salinity and provide a choice when deciding whether crops can be produced profitably in saline soils. It is a stress-tolerant crop that thrives in fields with low soil fertility, drought, and salt stress and it is thought to have greater defense mechanisms to combat various abiotic stresses [29].
Figure 5. Plan 1-2 of PCA, Parameters distribution. BP = Biomass production; PL = Plant length; CL = Cluster length; CD = Cluster diameter; CW = Cluster weight.

Figure 6. Dispersion of Pearl Millet accessions in the plan generated by the first two axes of PCA.
4. Conclusion

Clear variation in salt tolerance was observed among pearl millet genotypes. Based on plant height and fresh biomass accumulation values, we can conclude that IP22269 genotype was more tolerant to salinity, while MC94C2 was identified as sensitive. MC94C2 was again identified as sensitive genotype based on less cluster weight. High clusters weight and diameter was recorded for IP19586 and IP19612. Meanwhile, high cluster length was obtained with IP7704 and SVDANPOLIII. The found inter-genotypic variability should be used in improvement programs and later to locate the best recombination in progeny in order to adapt to Tunisia's extensive agro-ecological and pedoclimatic variation. More research is needed to corroborate these findings and develop further genetic investigations for breeding purposes.

References
[1] Mahmoud, NE, and Abdelhameed RA 2021, Superiority of modified graphene oxide for enhancing the growth, yield, and antioxidant potential of pearl millet (Pennisetum glaucum L.) under salt stress. Plant Stress 2, 100025.
[2] Hendawy, SF, El-Sherbeny SE, Hussein MS, and Youssef AA 2012, Evaluation of some cultivars of foxtail plants under salinity conditions. Journal of Applied Scientific Research 8, 620-627.
[3] Brink, M 2006, PROTA (Plant Resources of Tropical Africa / Ressources végétales de l’Afrique tropicale). Wageningen: Netherlands.
[4] Dong, YC, and Zheng DS 2006, Crops and Their Wild Relatives in China, China Agriculture Press, Beijing.
[5] Shannon, MC 1984, Breeding, selection and the genetics of salt tolerance. In: Staples RC, Toenissen GH (eds) Salinity tolerance in plants. John Wiley and Sons, New York, pp, 231–254.
[6] Ashraf, M, and McNeilly TM 1992, The potential for exploiting variation in salinity tolerance in pearl millet (Pennisetum americanum [L.] Leeke). Plant Breeding 104, 234–240.
[7] Krishnamurthy, L, Serraj R, Rai KN, Tom Hash C and Dakheel AJ 2007, Identification of pearl millet [Pennisetum glaucum (L.) R. Br.] lines tolerant to soil salinity. Euphytica 158, 179–188.
[8] Hussain, K, Ashraf M, and Ashraf MY 2008, Relationship between growth and ion relation in pearl millet (Pennisetum glaucum (L.) R. Br.) at different growth stages under salt stress. African Journal of Plant Science 2(3), 23-27.
[9] Johnsi Rani, R 2011, Salt stress tolerance and stress proteins in pearl millet (Pennisetum glaucum (L.) R. Br.). Journal of Applied Pharmaceutical Science 01(07), 185-188.
[10] Chopra, N, and Chopra N, 1993, Relative salt tolerance of pearl millet (Pennisetum glaucum) varieties in Marwar tract of Rajasthan. Indian Journal of Agriculture Research 63, 652–654.
[11] Munns, R, and Tester M 2008, Mechanisms of salinity tolerance. Annual Review of Plant Biology 59, 651–681.
[12] Muscolo A, Panuccio, MR and Sidari M 2003, Effects of salinity on growth, carbohydrate metabolism and nutritive properties of kikuyu grass (Pennisetum clandestinum Hochst). Plant Science 104, 1103–1110
[13] Dua, RP 1989, Salinity tolerance in pearl millet. Indian Journal of Agriculture Research 23, 9–14.
[14] Sabir, PM, Ashraf NA, and Akram A 2011, Accession variation for salt tolerance in proso millet (Panicum miliaceum L.) using leaf proline content and activities of some key antioxidant enzymes. Journal of Agronomy and Crop Science 197, 340–347.
[15] Wang, L, Wang XY, Weng QF, Wu BE, and Cao LP 2007, Identification of salt tolerance in Chinese prosomillet germplasm. Journal of Plant Genetic Resources 8, 426–429.
[16] Ardie, SW, Khumaidaa N, Nurb A, and Fauziah N 2015, Early Identification of salt tolerant
foxtail millet (Setaria italica L. Beauv). *Procedia Food Science* **3**, 303 – 312.

[17] Liu, Z, Zhu j, Yang X, Wu H, Wei Q, Wei H, and Zhang H 2018, Growth performance, organ level ionic relations and organic osmoregulation of Elaeagnus angustifolia in response to salt Stress. *Plos One* **13**(1), e0191552. https://doi.org/10.1371/journal.

[18] Liu, M, Qiao Z, Zhang S, Wang Y, and Lu P 2014, Response of broomcorn millet (Panicum miliaceum L.) genotypes from semiarid regions of China to salt stress. *The Crop Journal* **57**, 66. http://dx.doi.org/10.1016/j.cj.2014.08.006.

[19] Akrimi, R, Hajlaoui H, Ruggiero A, Badri M, Grillo S, and Mhamdi M 2021, Electromagnetic water enhanced metabolism and agro- physiological responses of potato (Solanum tuberosum L) under saline conditions. *Journal of Agronomy and Crop Science* **207** (1), 44-58.

[20] Louati, D, Majdoub R, Rigane H, and Abida H 2018, Effects of irrigation with saline water on soil salinization (Eastern Tunisia). *Arabian Journal for Science and Engineering* **43**, 3793-3805.

[21] Hajrasuliha, SN, Baniabassi J, and Nilson DR 1980, Special variability in soil sampling for salinity studies in Southwest Iran. *Irrigation Science* **1**, 197–208.

[22] Kingsbury, PW, and Epstein E 1984, Selection for salt resistant in spring wheat. *Crop Science* **24**, 310–315.

[23] Lonov, M, Yuldasheva N, Ulchenko N, Glushenkov AI, and Heuer B 2013, Growth, development and yield of Crambe abyssinica under saline irrigation in the greenhouse. *Journal of Agronomy and Crop Science* **199**, 331–339.

[24] Guandalia, JD, Patel MS, Polara KB, and Tank NK 1992, Relative salinity tolerance of pearl millet genotypes. *Gujrat Agriculture University Research Journal* **18**, 24-30.

[25] Krishnamurthy, L, Serraj, R, Tom Hash, C, Dakheel, AJ and Belum, VSR 2007, Screening sorghum genotypes for salinity tolerant biomass production. *Euphytica* **156**, 15–24

[26] Bessa, MC, Lacerda, CF, Amorim, AV, Bezerra, AME and Lima, AD 2017, Mechanisms of salt tolerance in seedlings of six woody native species of the Brazilian semi-arid. *Revista Ciência Agronômica* **48** (1), 157–165.

[27] Allen RG, Pereira LS, Raes D, and Smith M 1998, Crop evapotranspiration. FAO. Irrigation and drainage paper. 56-326.

[28] Khan, MB, Mohammad S, and Bakht J 2000, Yield and yield components of pearl millet as affected by various salinity levels. *Pakistan Journal of Biological Sciences* **3**(9), 1393-1396.

[29] Singh, J, Reddy PS, Reddy CS, and Reddy KM 2015, Molecular cloning and characterization of salt inducible dehydration gene from the C4 plant Pennisetum glaucum. *Plant Gene* **4**, 55–63.