# Impact of salinity on physiological and biochemical traits in pearl millet

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Salinity is one of the most severe environmental factors limiting the productivity of agricultural crops in arid and semi-arid regions. Accumulation of excess salts in the rhizospheric environment results in disturbed metabolic processes which commonly manifested in nutrient imbalance, reduced nutrient uptake including $K^+$, specific ion toxicity, distinctly changed concentrations of key biomolecules, inhibited plant growth to osmotic stress and ultimately poor productivity. Salinity management through improved irrigation techniques is viable option but quite expensive one. Therefore, crop improvement could be less expensive and a more sustainable solution for agricultural use of salt affected soils (Krishnamurthy *et al.*, 2007). Pearl millet (*Pennisetum glaucum*) is a warm season coarse grain cereal generally considered as fairly tolerant to salinity. Salt tolerance has been identified as a developmentally regulated, stage-specific phenomenon. Variation in whole-plant reaction to salinity provides the most efficient initial screening for salinity tolerance. The present investigation was carried out to explore the genotypic variability in pearl millet and to identify the key physiological and biochemical traits influencing crop growth and development during the stress periods.

## METHODOLOGY

A set of twelve pearl millet hybrids was procured from ICRISAT, Hyderabad and CCS HAU, Hisar. Five hybrids from ICRISAT involved high biomass pollinator germplasm and were earlier identified for having high green/dry biomass for forage purpose, while seven hybrids from CCSHAU Hisar were dual purpose hybrids (bred for both grain yield and fodder purpose). ICRISAT hybrids reported 45–55 tonnes/ha of green biomass and 15–20 tonnes/ha of dry biomass at 80-90 days after planting, based on multi-location evaluation in 2014 in India (Gupta *et al.*, 2015). This set of hybrids was sown in clay/porcelain pots of 20 kg capacity filled with 16 kg saline soil ($EC_e$ 7.9 dS/m) having field capacity 28% (v/v), bulk density 1.45 g/cc and porosity 40% at ICAR-Central Soil Salinity Research Institute (CSSRI), Karnal during *Kharif* 2015 in a randomized complete block design replicated thrice. Nine seeds of each hybrid were sown in three equally spaced hills in each pot and irrigated with deionized water to field capacity previously estimated for the soil. Osmotic stress was imposed by applying saline irrigation water of $EC_{iw}$ 3, 6 and 9 $dSm^1$ along with best available water (BAW) having $EC_{iw}$ 0.6 dS/m (control). The data on physiological and biochemical parameters by taking fully expanded leaves separately for measurement of chlorophyll content, total soluble sugars, proline and protein content. Ionic ($Na^+$ and $K^+$) content were determined from well ground plant material using di-acid mixture ($HNO_3 : HClO_4$ 3 : 1) onflame photometer (PFP7, Jenway, Bibby Scientific, UK).

## RESULTS

At final harvest, the resultant soil salinity ($EC_e$) withsaline irrigation water treatments was found to be 6.36, 7.96 and 9.68 dS/m at $EC_{iw}$ of 3, 6 and 9 dS/m as against the $EC_e$ of 4.4 dS/m in the BAW treated pots (control). Pearlmillet hybrid ICMA 01888 × IP 6140 and HHB 272 maintained their RWC content more than 80% at $EC_{iw}$ 9 dS/m closely followed HHB 226 and ICMA 00444 × IP 13150 (Table 1). Maximum reduction (42.6%) in RWC was noticed in ICMA 03222 × ICMV 05777 at $EC_{iw}$ 9 dS/m. Membrane injury increased with the increase in saline irrigation level. However, a gradual decrease was recorded in chlorophyll content. Overall, ICRISAT hybrids showed lower per cent injury (< 30%) and higher chlorophyll concentration (>35 μg/ml) at $EC_{iw}$ 9 dS/m. Increased proline accumulation was observed in all the test hybrids with increasing irrigation water. Highest proline content (7.29 mg/g FW) was observed in ICMA 00444 × IP 6202 while lowest (5.34 mg/g FW) was recorded with HHB 67 IMP. The proline accumulation was more in CCSHAU hybrids compared to ICRISAT hybrids (Table 1). Mean yield reduction of 16.0, 37.1 and 64.4 per cent was recorded when saline irrigation water of 3, 6 and 9 dS/m was applied in comparison to BAW (14.43 g/plant). The performance of CCSHAU hybrids was relatively better with increasing irrigation water salinity. The mean per cent reduction in grain yield of pearl millet hybrids collected form CCSHAU hybrids was 15.0, 30.3 and 58.5 $EC_{iw}$ of 3, 6 and 9 dS/m, respectively while the corresponding values were 17.5, 47.8 and 67.5 per cent, respectively for ICRISAT hybrids. Pearl millet hybrids HHB 223, HHB 272, HHB 146, ICMA 004444 × IP 13150 and ICMA 03222 × ICMV 05777 were found to the promising ones showing lesser yield reduction and lower Na/K ratio in the shoot with the increasing irrigation water salinity.

**Table 1.** Effect of irrigation water salinity on the physiological and biochemical parameters in pearl millet hybrids

| Hybrid | Relative water content (%) | | Membrane injury (%) | | Chlorophyll (μg/ml) | | Proline (mg/g FW) | |
|---|---|---|---|---|---|---|---|---|
| | Control | $EC_{iw}$9 dS/m | Control | $EC_{iw}$9 dS/m | Control | $EC_{iw}$9 dS/m | Control | $EC_{iw}$9 dS/m |
| ICRISAT | | | | | | | | |
| ICMA 00444 × IP 6202 | 90.35 | 70.33 | 2.73 | 32.11 | 52.43 | 37.15 | 1.71 | 7.29 |
| ICMA 03222 × ICMV 05777 | 95.75 | 42.57 | 6.63 | 26.81 | 54.38 | 39.99 | 1.49 | 5.36 |
| ICMA 00999 × IP 6202 | 89.32 | 75.40 | 7.39 | 31.89 | 54.03 | 34.92 | 1.35 | 5.95 |
| ICMA 01888 × IP 6140 | 89.10 | 80.14 | 6.84 | 31.41 | 52.21 | 36.08 | 1.37 | 6.44 |
| ICMA 00444 × IP 13150 | 93.04 | 75.44 | 7.31 | 31.23 | 53.70 | 33.75 | 1.07 | 6.57 |
| Mean | 91.51 | 68.78 | 6.18 | 30.69 | 53.35 | 36.38 | 1.40 | 6.32 |
| CCSHAU | | | | | | | | |
| HHB 67 IMP | 88.82 | 69.55 | 8.08 | 32.53 | 53.64 | 36.66 | 0.87 | 5.44 |
| HHB 146 | 96.76 | 73.03 | 8.42 | 31.35 | 53.66 | 28.37 | 1.73 | 7.17 |
| HHB 197 | 87.51 | 68.90 | 5.84 | 29.33 | 53.66 | 31.50 | 1.31 | 6.55 |
| HHB 226 | 91.56 | 76.68 | 5.45 | 42.66 | 53.68 | 34.73 | 1.22 | 6.34 |
| HHB 223 | 92.66 | 72.60 | 9.53 | 34.96 | 53.72 | 29.52 | 1.41 | 7.12 |
| HHB 234 | 90.05 | 64.08 | 10.63 | 41.08 | 53.69 | 35.64 | 1.61 | 7.13 |
| HHB 272 | 92.49 | 78.87 | 7.12 | 38.35 | 61.56 | 35.06 | 0.64 | 5.74 |
| Mean | 90.85 | 72.23 | 7.71 | 37.28 | 55.26 | 33.29 | 1.24 | 6.58 |

## CONCLUSION

Substantial variation for salinity tolerance exists in between pearl millet hybrids owing to variable physiological and biochemical response under different salinity irrigation water. These can be used as useful selection criteria for identifying salt tolerant hybrids for improving the adaptation as well as yield potential of this crop under arid and semi-arid climatic conditions.

## REFERENCES

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