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Physiological, Biochemical and Yield Traits of Pearl-millet (*Pennisetum glaucum* L.) Accessions under Saline Irrigation

G Makarana[1], RK Yadav[2]*, A Kumar[2], R Kumar[1], P Sheoran[2], M Kushwaha[1] and T Yadav[1]

[1]*ICAR-National Dairy Research Institute, Karnal-132001, Haryana, India*
[2]*ICAR-Central Soil Salinity Research Institute, Karnal-132001, Haryana, India*
**Corresponding author E-mail: RK.Yadav@icar.gov.in*

Abstract

A field experiment was conducted to assess variation in physiological, biochemical and yield attributes, influencing production potential, of 20 pearl millet (*Pennisetum glaucum* L.) accessions (ICFH-1 to 20) under saline irrigation (EC 6.0 dS m^{-1}). Among the twenty accessions, ICFH-15 recorded the highest relative water content (88.38 and 77.99 %), total chlorophyll content (66.75 and 59.87 µg ml^{-1} FW) and total soluble protein (39.98 and 25.50 mg g^{-1} DW) at 50 and 80 days after sowing, respectively. However, accession ICFH-4 showed the highest membrane injury (15.73 and 24.33%) at respective stages. ICFH-7 accumulated the maximum proline (2.70 and 5.54 µg g^{-1} FW), total soluble sugar (20.54 and 20.76 mg g^{-1} DW), epicuticular wax content (2.85 and 4.44 mg g^{-1} DW) at the two stages. The maximum dry matter yield was achieved in ICFH-15 (14.83 Mg ha^{-1}) followed by ICFH-16 (13.46 Mg ha^{-1}). Whereas the highest grain yield was recorded in accession ICFH-5 (3.68 Mg ha^{-1}) followed by ICFH-2 and ICFH-7 (3.14 Mg ha^{-1}). Our results suggested that ICFH -15 and ICFH -16 were suitable for dry matter yield (dry fodder purpose) while accessions ICFH-5, ICFH-2 and 7 for higher grain yield under saline irrigation conditions of north-western India and elsewhere under similar agro-climatic conditions.

Key words: Saline water, Pearl-millet, Physiological, Biochemical, Yield attributes

Introduction

Presence of salt-affected soils on the earth surface is as old as the history of mankind (Sharma and Chaudhari, 2012). Now it has been recognized as a very serious threat for crop production (Ashraf and Wu 1994; Rengasamy 2006), particularly in arid and semi-arid regions, which constitute about one third of the world's land surface. According to an estimate all over the world, 831 million ha of land is salt-affected, either by salinity (397 million ha) or the associated condition of sodicity (434 million ha) (FAO, 2005). Out of the current area of 230 million ha of irrigated land, 45 million ha (20%) is considered to be salt-affected (Pitman and Lauchli, 2002) and estimated stressed area will intensify to 50% of irrigated land by 2050 (Wang *et al.*, 2003). The magnitude of salt-affected soils is highest in Asia Pacific region countries (FAO, 2005). At present about 6.73 million hectares (M ha) salt-affected soils exist in India in which 2.96 M ha are saline and remaining 3.77 M ha are characterized as sodic soils. Now-a-days, due to inter-sector competition as a consequence of rising population, fresh water supply to agriculture is reducing. In arid and semi-arid parts of India besides soil salinity, groundwater is of poor-quality which occupies 32-84% of ground water resources (CGWB, 1997). The over-draft of groundwater is causing decline in water table at alarming rates and causing quality deterioration further in these areas. Its indiscriminate use poses a serious threat to sustainability of the natural resources and environment. Each year, India loses 16.84 million tons of cereals, oilseeds, pulses and commercial crops from these stressed zones and accounts a loss of ^{1} 230.19 billion (Sharma *et al.,* 2015). Particularly farmers of Rajasthan and Haryana have to depend on poor-quality ground water which is 68 and 55%, respectively in the two states (Lal *et al.,* 2008). Salinity is very complex and causes several physiological disorders in plants including membrane damage, nutrient imbalance, altered levels of growth regulators, enzymatic inhibition and metabolic dysfunction, including photosynthesis which ultimately leads to plant death (Mahajan and Tuteja, 2005). In this context, the pearl millet (*Pennisetum glaucum* L.) is promising multi-purpose, short duration, coarse grained crop with good salinity tolerant characteristics. Therefore, present systematic study was carried out to assess the production potential in association with physiological and biochemical responses of different accessions of pearl-millet under saline irrigation conditions.

Material and Methods

Site and climate description

This study was carried out in *kharif* 2015-16 at ICAR-CSSRI Research Farm Nain village (29°19′ N, 76°47′E and 230.5 m above the mean sea level), Panipat district, Haryana, India. Climate of the area is semi-arid monsoonal type with ~ 600 and 1350 mm annual average rainfall and evapo-transpiration, respectively. More than 75% of the total annual rainfall occurs during July to September. The meteorological data recorded during the study period (July-November) is depicted in Table 1. The soil of the study site is sandy loam and saline (ECe 6.7 dS m^{-1}). The initial soil conditions and after harvest soil salinity status of experimental site is presented in Table 2.

Description of accessions and agronomic practices

Twenty pearl millet accessions (ICFH 1 to ICFH 20) were collected from ICRISAT, Hyderabad and assessed for their physiological and biological responses culminating into yield attributes and yield. All the accessions were grown with recommended package of agronomic practices for pearl-millet. In addition to total rainfall, supplemental irrigations of saline water (~6.0 dS m^{-1}) were applied at 1.2 ID/CPE to meet the crop water requirement. Salinity build-up of ~ 6.83 and 6.85 dS m^{-1} in 0-15 and 15-30 cm soil depth was noticed at harvest of the crop. Seed rate of 12 kg ha^{-1} and row spacing: 30 cm ×10 cm was adopted under this study. A common dose of nutrients amounting 120 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} was applied. The 1/3rd N and whole P_2O_5 and K_2O was applied as basal, while remaining 2/3rd N was top dressed as urea in two equal splits at 50 and 80 days after sowing (DAS). In view of best weed management, all the plots were manually weeded at 30 DAS.

Table 2. Initial soil status of experimental site

Texture	Sandy loam
Walkley–Black C (%)	0.3
ECe (dS m^{-1})	6.65
pHs	8.3
$KMnO_4$ oxidizable N (kg ha^{-1})	130.4
0.5 M $NaHCO_3$ extractable P (kg ha^{-1})	11.6
1N NH_4OAC extractable K (kg ha^{-1})	248.4

Measurement of observations

The first cut of crop was taken at (50 DAS) at ~10 cm above the ground level. Then the crop was raised for grain production. Dry matter yield (DMY) at 50 DAS and at grain harvest are summed for total DMY. Yields of 1 m×1 m randomly at 3 places in each treatment was recorded and converted in per hectare area. Fully expanded leaves were sampled for measurement of physiological attributes at 50 and 80 DAS. Relative water content (RWC) was measured following the procedure described by Weatherley (1950). Membrane injury was estimated according to the method of Dionisio-Sese and Tobita (1998). The chlorophyll content was determined using DMSO (Dimethyl sulphoxide) as described by

Table 1. Meteorological observations during study period

Month	Temperature (°C)		Relative humidity (%)		Total rainfall	Total evaporation
	Mean Max	Mean Min	Mean Max.	Mean Min.	(mm)	(mm)
20-31 July	32.92	25.4	86.08	69.67	11.4	71.2
1-31 August	32.68	25.1	92.97	73.2	70.2	103.6
1-30 September	33.51	22.8	91.5	59.2	46.8	106.5
1-31 October	32.15	17.77	91.67	46.3	6.4	90.7
1-15 November	27.73	14.19	91.56	47.06	9.2	30.3

Hiscox and Israelstam (1979). Freshly harvested plants were weighed and analyzed for total soluble sugars (Yemm and Wills 1954), protein content (Bradford 1976), proline (Bates *et al.,* 1973) and epicuticular wax load (Ebercon *et al.,* 1977). For Na^+ and K^+ content, 100 mg of oven dried and well ground plant material was digested with 10 ml of HNO_3: $HClO_4$ (3:1) di-acid mixture and readings were taken with flame photometer (PFP7, Jenway, Bibby Scientific, UK) using standard NaCl and KCl.

Experimental design and statistical analysis

The experiment was carried out in RBD with three replications. Twenty accessions of pearl-millet, cultivated with recommended package of agronomic practices were assessed for variation in physiological, biochemical and yield attributes, influencing production potential under saline conditions. All data pertaining to above mentioned parameters were recorded and analyzed with the help of analysis of variance technique using the SAS (Version 9.3, SAS Institute Inc., Cary, NC, USA). Correlation analysis was performed to determine the relationship between the traits using the Pearson correlation coefficient.

Results and Discussion

Physiological and biochemical attributes

The maximum RWC of 88.38 and 77.99 % was recorded in accession number ICFH-15 at 50 and 80 DAS, respectively. In general, with advancement of crop maturity the RWC content decreased (Fig. 1). Osmotic adjustment (OA) is a prevailing mechanism of conserving cellular hydration under stress and RWC expresses the effect of OA in this respect. Hence RWC is an appropriate measure of plant water status in terms of cellular hydration under the possible effect of both leaf water potential and OA. The active reduction in RWC through accumulation of compatible solutes, as demonstrated in a wide range of species, is known to manifest as OA. Our findings are in agreement with several researchers likes Netondo *et al.* (2004) in sorghum and Vijayalakshmi *et al.* (2012) in pearl millet.

It is well documented that salinity per se and irrigation water salinity as such has adverse effect on total chlorophyll content (TCC). Chlorophyll concentration has been known as an index for evaluation of source, therefore decrease in concentration can be considered as a stomata non-limiting factor under stress conditions. The observations with respect to TCC as affected by different accession are presented in figure 2.

ICFH-15 and 16 recorded significantly higher ($p<0.05$) TCC i.e. 66.75 and 64.38 $\mu g ml^{-1}$, respectively at 50 DAS, while ICFH-7 showed the lowest TCC (55.19 $\mu g ml^{-1}$). Similar trend continued even at 80 DAS. In general, with advancement in age of plants, decrease in chlorophyll content was observed. The accession which recorded lower TCC might have the

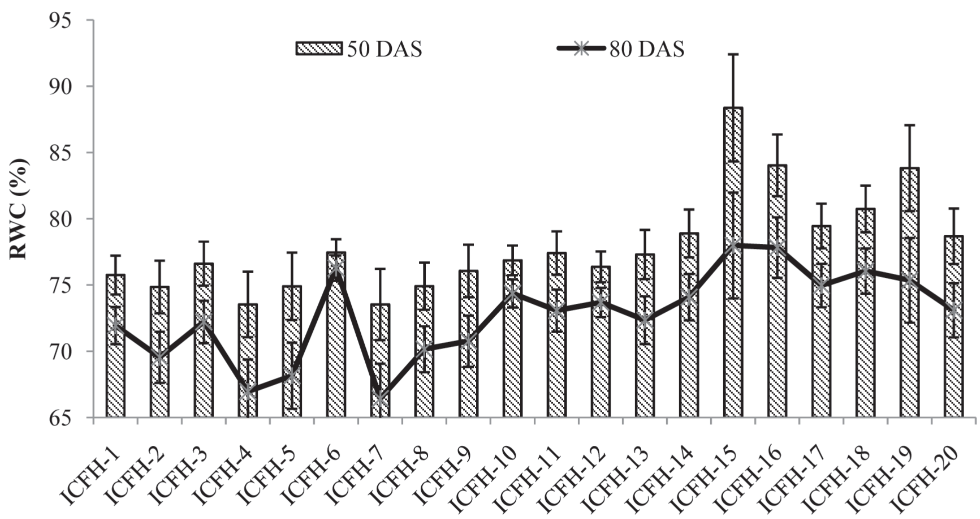

Fig. 1. Relative water content (%) of pearl millet accessions as influenced by saline irrigation

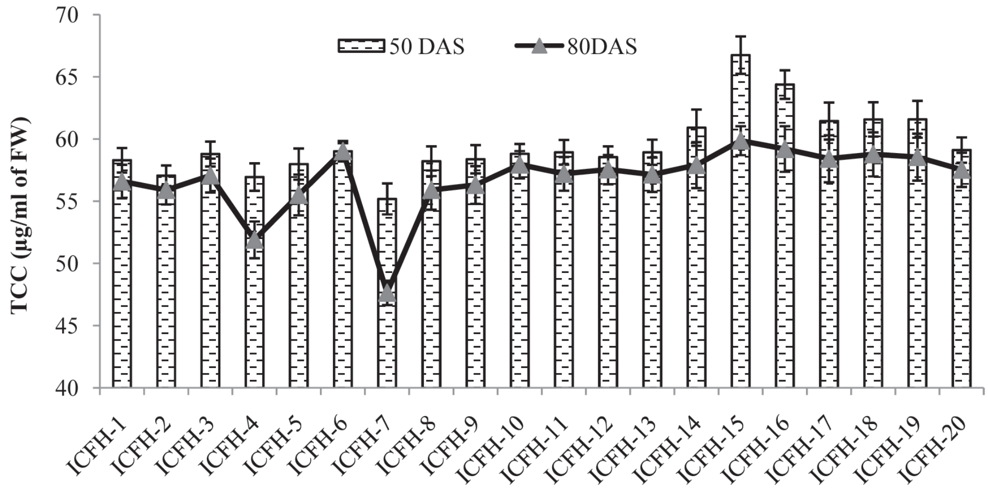

Fig. 2 Total chlorophyll content (µg ml^{-1} of FW) of pearl millet accessions as influenced by saline irrigation

destruction of chlorophyll 'a' which is considered to be more sensitive to salinity than chlorophyll 'b'. Albassam *et al.* (2001) and Nadaf *et al.* (2010) also noticed variability among the pearl millet genotypes/lines and decrease in chlorophyll content under saline irrigation water.

Proline accumulation is an important physiological index for plant response to abiotic stresses. Previously it was not mentioned whether pearl-millet accumulates osmolytes, such as proline, under salt stress because the crop is generally taken as rain-fed. Variation in proline content, presented in figure 3, indicated that accumulation differed among accessions under saline environment. Minimum proline content (0.53 and 1.02 µgg^{-1} FW) was recorded in accession ICFH-15 at 50 and 80 DAS, respectively. ICFH-7 had accumulated the highest ($p<0.05$) value at both the stages. These findings are in close agreement with earlier findings of Heidari *et al.* (2011).

A varying response on membrane injury (MI) was observed among different accessions (Table 3). Percentage of membrane injury was estimated from the electrolyte leakage of the stressed plants. Leaves of pearl millet accession ICFH-15 exhibited lowest (7.30 and 10.74 % at 50 and 80 DAS, respectively) MI than all other accessions. Molaei *et al.* (2015) also reported varying responses in cultivars under water and salt stress. The accumulation of soluble carbohydrates in plants has been widely reported as a response to salinity or drought, despite a significant decrease in net CO_2 assimilation rate (Murakeozy *et al.,*

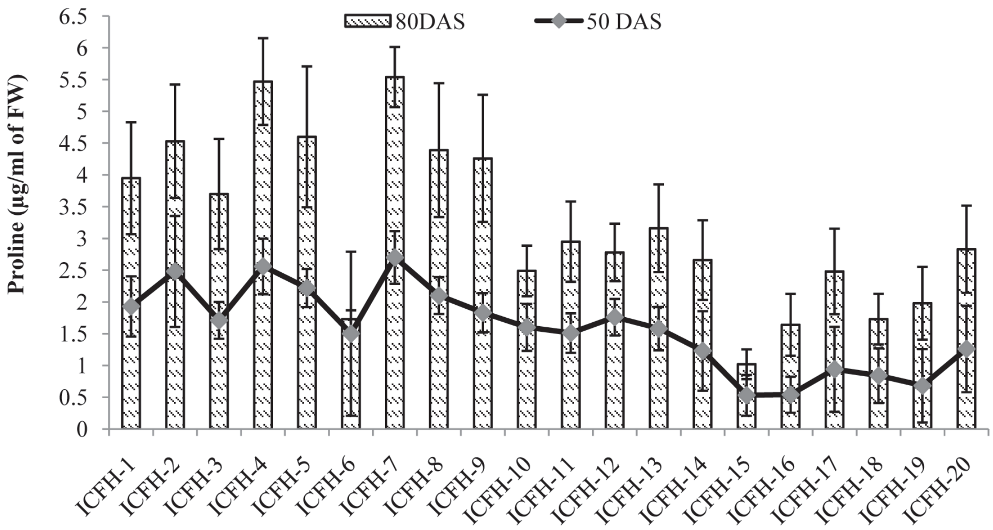

Fig. 3 Proline content (µg $g^{-1}$of FW) of pearl millet accession at 50 and 80 days after sowing

2003). Significant variations in total soluble sugar content (TSS) (mg g^{-1} DW) were noticed in different accessions as exhibited in Table 3. The lowermost ($p<0.05$) value for TSS was recorded in accession number ICFH-15 (6.64 and 6.04 mg g^{-1} DW at 50 and 80 DAS). The highest value for this parameter was noticed in ICFH 7 at 50 and 80 DAS. Similar observations have been recorded by Govind *et al.* (2019) in pearl-millet.

A varying response in epicuticular wax content (EWC) accumulation was observed among the genotypes (Table 3). Minimum EWC was recorded in accession number ICFH-15 at both observations and respective values were (0.88 and 2.39 mg g^{-1} DW) at 50 and 80 DAS. EW increases in leaves of water deficient plants and positively correlated with cuticular conductance. Kumar *et al.* (2016) also reported increased EW load with salt stress in halophytes. Data pertaining to total soluble protein (TSP) are presented in Table 3. The highest magnitude of difference was observed (45.75 and 50.95% at 50 and 80 DAS, respectively) between accession ICFH-15 (39.98 and 25.50 mg g^{-1} DW at 50 and 80 DAS, respectively) and ICFH-07(21.69 and 12.36 mg g^{-1} DW at 50 and 80 DAS). Earlier also several researchers have noticed variations among genotypes and decrement of TSP in leaves of plants exposed to salinity (Agastian *et al.,* 2000; Wang *et al.,* 2000; Parida *et al.,* 2002).

Ionic concentration

Concentrations of Na^+ and K^+ were determined in roots and shoots on dry matter basis. Ionic concentration is one of the basic mechanisms of plant defense which relies on the compartmentalization of toxic ions in the vacuoles, allowing osmotic adjustment. Different genotypes have varying potential to withstand salinity conditions. Data pertaining to ion concentration in different accessions are presented in Table 3 and figure 4-5. It is evident that both K and Na content in root as well as in shoot were having inverse relationship. In the accession ICFH-15, the maximum K^+ content was observed at all study stages of observations while Na^+ content was lowest in same accession. The higher affinity for K^+ transporters may also act as lower affinity for Na^+ transporters under saline environment, which may reduce K^+ uptake. Our results are supported by the findings of Liu *et al.* (2000) and Radhouane *et al.* (2013).

Yield attributes

Different accessions influenced all attributes of yield *viz.*, panicles per plant, ear head length, ear head girth, test weight and grains per panicle (Table 4). Accession ICFH-5 recorded the maximum panicles per plant (7.28), ear head length (31.44 cm), ear head girth (7.60 cm), test weight (8.92 g) and grains per panicle (2187.8), while ICFH-9 produced least values of all these

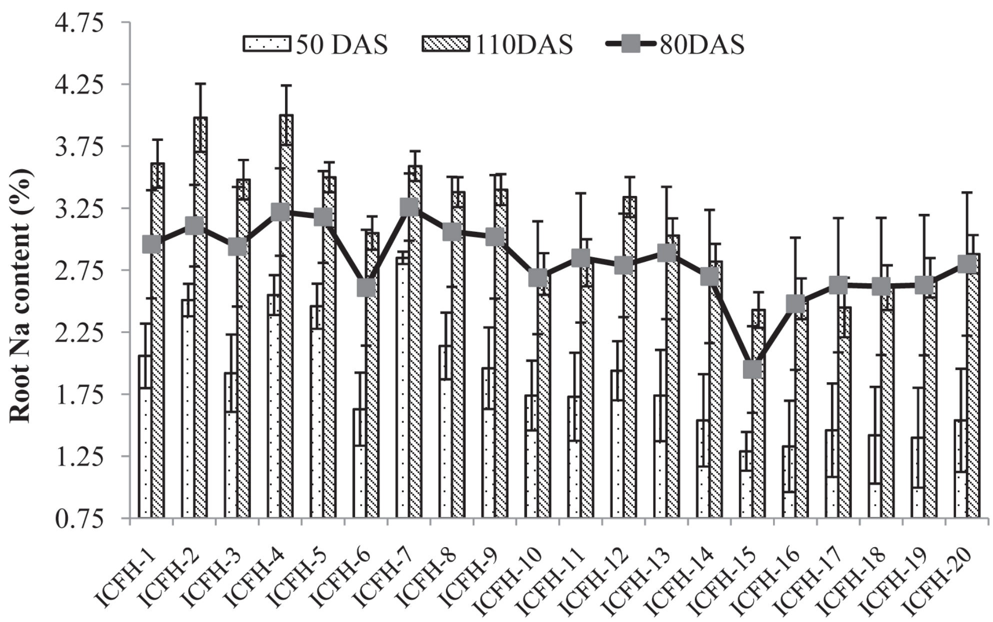

Fig. 4 Root Na content (%DW) of pearl-millet accessions at 50, 80 and 110 days after sowing

Table 3. Physiological and biochemical traits of different pearl-millet accessions as affected by saline water irrigation

Pearl-millet accessions	Membrane injury (%)		Epicuticular wax (mg g^{-1} DW)		Total soluble sugar (mg g^{-1} DW)		Total soluble protein (mg g^{-1} DW)		Shoot K^{+} (% DW)			Shoot Na^{+} (% DW)		
	50 DAS	80 DAS	50 DAS	80 DAS	50 DAS	80 DAS	50 DAS	80 DAS	50 DAS	80 DAS	110 DAS	50 DAS	80 DAS	110 DAS
ICFH-1	10.28^{ef}	21.86^{ef}	2.65^{cd}	3.92^{g}	9.89^{cde}	12.^{72defg}	23.91^{cd}	19.80^{d}	2.83^{cd}	2.83^{d}	0.79^{abc}	0.19^{hi}	0.43^{ef}	3.16^{j}
ICFH-2	12.51^{g}	23.36^{efg}	2.74^{d}	4.19^{h}	11.22^{de}	14.53^{gh}	23.01^{bc}	17.39^{bc}	2.73^{c}	2.84^{d}	0.77^{ab}	0.22^{k}	0.50^{g}	3.34^{k}
ICFH-3	9.71^{cde}	21.56^{e}	2.61^{cd}	3.90^{g}	9.07^{abcd}	12.56^{cdefg}	25.18^{e}	22.34^{e}	2.84^{d}	2.73^{c}	1.00^{d}	0.17^{fg}	0.43^{ef}	2.58^{h}
ICFH-4	15.73^{h}	24.33^{g}	2.75^{d}	4.28^{h}	11.92^{e}	16.29^{h}	22.39^{ab}	15.86^{b}	2.47^{ab}	2.80^{cd}	0.67^{a}	0.22^{k}	0.69^{i}	4.47^{l}
ICFH-5	10.88^{f}	24.23^{fg}	2.69^{cd}	4.19^{h}	11.04^{de}	14.95^{gh}	23.11^{bcd}	16.51^{b}	2.50^{b}	2.47^{ab}	0.98^{cd}	0.21^{jk}	0.58^{h}	2.76^{i}
ICFH-6	8.99^{bcd}	13.07^{bc}	2.50^{cd}	2.56^{b}	8.83^{abcd}	9.57^{bc}	27.05^{gh}	24.48^{fg}	4.18^{h}	2.50^{b}	1.38^{e}	0.15^{de}	0.33^{b}	1.56^{f}
ICFH-7	16.74^{i}	28.50^{h}	2.85^{d}	4.44^{i}	20.54^{f}	20.76^{i}	21.69^{a}	12.89^{a}	2.39^{a}	3.69^{h}	0.92^{bcd}	0.25^{l}	1.20^{j}	2.87^{i}
ICFH-8	10.34^{ef}	22.83^{efg}	2.65^{cd}	4.00^{g}	10.93^{de}	13.74^{fgh}	23.16^{bcd}	18.90^{cd}	2.80^{cd}	2.39^{a}	1.37^{e}	0.20^{ij}	0.44^{f}	2.45^{h}
ICFH-9	9.9^{def}	22.45^{efg}	2.63^{cd}	3.97^{g}	9.74^{bcde}	13.45^{efgh}	23.92^{cd}	20.13^{d}	2.81^{cd}	3.68^{gh}	1.33^{e}	0.18^{h}	0.44^{f}	2.50^{h}
ICFH-10	9.63^{cde}	17.00^{d}	2.60^{cd}	3.23^{d}	8.95^{abcd}	10.63^{bcde}	25.69^{ef}	24.22^{fg}	3.69^{f}	3.98^{i}	1.78^{fg}	0.17^{fg}	0.37^{cd}	1.18^{bcde}
ICFH-11	9.34^{bcde}	18.64^{d}	2.50^{cd}	3.73^{f}	8.87^{abcd}	12.09^{cdefg}	26.82^{gh}	23.36^{ef}	3.41^{e}	2.81^{cd}	1.72^{f}	0.16^{ef}	0.40^{de}	1.20^{bcde}
ICFH-12	9.94^{cdef}	17.34^{d}	2.63^{cd}	3.27^{d}	9.10^{abcd}	11.16^{cdef}	24.13^{d}	23.52^{ef}	3.60^{f}	4.45^{k}	1.38^{e}	0.18^{gh}	0.38^{d}	1.73^{g}
ICFH-13	9.61^{cde}	21.27^{e}	2.58^{cd}	3.76^{f}	8.87^{abcd}	12.10^{cdefg}	26.37^{fg}	23.29^{ef}	3.32^{e}	3.41^{f}	1.51^{e}	0.16^{ef}	0.43^{ef}	1.33^{e}
ICFH-14	8.38^{ab}	17.29^{d}	2.36^{cd}	3.24^{d}	8.12^{abc}	10.93^{cdef}	29.04^{i}	23.85^{ef}	3.68^{f}	3.42^{f}	1.53^{e}	0.14^{cd}	0.38^{d}	1.23^{cde}
ICFH-15	7.30^{a}	10.74^{a}	0.88^{a}	2.39^{a}	6.64^{a}	6.04^{a}	39.98^{m}	26.03^{g}	4.45^{i}	4.12^{j}	2.03^{h}	0.09^{a}	0.26^{a}	0.74^{a}
ICFH-16	7.62^{a}	11.12^{ab}	0.94^{a}	2.48^{ab}	7.30^{ab}	7.84^{ab}	38.45^{l}	25.01^{fg}	4.39^{i}	4.39^{k}	1.95^{gh}	0.10^{a}	0.26^{a}	1.06^{bc}
ICFH-17	8.33^{ab}	16.77^{d}	2.21^{c}	2.72^{c}	7.89^{abc}	10.28^{bcd}	33.04^{j}	24.23^{fg}	3.70^{f}	4.18^{j}	1.96^{gh}	0.13^{bc}	0.34^{bc}	1.02^{b}
ICFH-18	8.31^{ab}	13.68^{c}	1.66^{b}	2.70^{c}	7.89^{abc}	9.59^{bc}	34.50^{k}	24.39^{fg}	4.12^{h}	3.60^{g}	1.90^{fgh}	0.13^{bc}	0.34^{bc}	1.10^{bcd}
ICFH-19	8.21^{ab}	16.27^{d}	1.45^{b}	2.72^{c}	7.76^{abc}	9.97^{bcd}	34.96^{k}	24.27^{fg}	3.98^{g}	3.32^{e}	1.79^{fg}	0.12^{b}	0.34^{bc}	1.11^{bcd}
ICFH-20	8.81^{bc}	17.44^{d}	2.41^{cd}	3.58^{e}	8.38^{abc}	11.32^{cdef}	27.71^{h}	23.41^{ef}	3.42^{e}	3.70^{h}	1.52^{e}	0.14^{cd}	0.38^{d}	1.28^{de}
SEm±	0.60	1.30	0.26	0.08	1.26	1.60	2.50	1.60	0.06	0.05	0.11	0.01	0.02	0.10
LSD ($p \leq 0.05$)	1.22	2.64	0.53	0.15	2.55	3.25	5.07	3.23	0.13	0.10	0.23	0.06	0.04	0.20

DAS-Days after sowing, Values in table containing different superscripts are significantly different with each other.

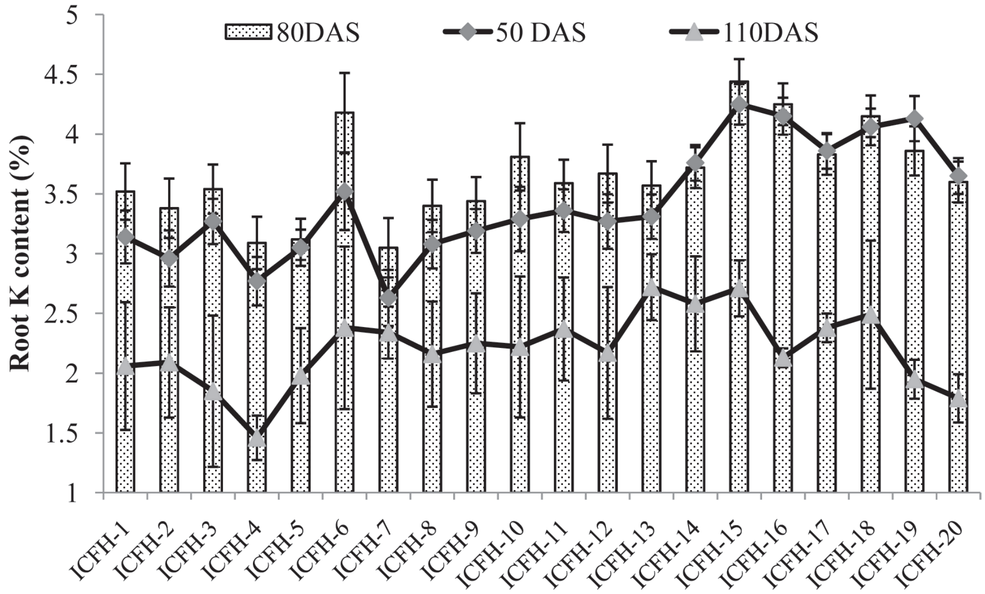

Fig. 5 Root K content (% DW) of pearl millet accessions at 50, 80 and 110 days after sowing

Table 4. Yield attributes and yield of pearl-millet accessions under saline environment

Pearl-millet accessions	Panicle per plant	Earhead length (cm)	Earhead Girth (cm)	Test weight (g)	Grains per panicle	Grain yield (Mg ha^{-1})	Dry matter yield (Mg ha^{-1})
ICFH-1	5.00	23.11^{ab}	6.81^{c}	7.07^{abcde}	1828.5^{abcde}	1.94^{abcd}	11.47^{bcd}
ICFH-2	7.00	28.14^{ab}	7.40^{hi}	8.32^{ef}	2183.6^{f}	3.14^{fg}	10.86^{bc}
ICFH-3	4.67	22.11^{ab}	6.78^{c}	6.60^{abc}	1693.9^{abc}	1.44^{a}	12.19^{de}
ICFH-4	6.33	26.37^{ab}	7.09^{fg}	7.94^{cdef}	2072.9^{def}	3.02^{efg}	10.59^{ab}
ICFH-5	7.28	31.44^{b}	7.60^{i}	8.92^{f}	2187.8^{f}	3.68^{g}	10.79^{ab}
ICFH-6	6.67	26.45^{ab}	7.22^{gh}	8.05^{cdef}	2082.2^{def}	3.03^{efg}	12.00^{de}
ICFH-7	5.67	24.30^{ab}	6.88^{cdef}	7.45^{bcde}	1884.8^{bcdef}	2.44^{bcdef}	9.78^{a}
ICFH-8	5.50	23.72^{ab}	6.87^{cdef}	7.29^{abcde}	1870.7^{bcdef}	2.11^{abcde}	11.48^{bcd}
ICFH-9	4.00	17.54^{a}	5.42^{a}	5.91^{a}	1513.9^{a}	1.21^{a}	10.73^{ab}
ICFH-10	4.17	21.43^{ab}	6.50^{b}	6.44^{ab}	1567.0^{ab}	1.25^{a}	11.64^{bcde}
ICFH-11	6.00	25.41^{ab}	7.07^{efg}	7.92^{cdef}	2040.1^{def}	2.73^{def}	11.49^{bcd}
ICFH-12	5.07	23.13^{ab}	6.82^{cd}	7.20^{abcde}	1833.8^{abcde}	1.99^{abcd}	11.97^{cde}
ICFH-13	4.33	21.93^{ab}	6.52^{b}	6.59^{abc}	1691.0^{abc}	1.36^{a}	11.92^{cde}
ICFH-14	5.00	22.95^{ab}	6.81^{c}	7.04^{abcde}	1763.0^{abcd}	1.69^{abc}	12.17^{de}
ICFH-15	5.67	25.29^{ab}	7.01^{cdefg}	7.59^{bcdef}	1988.8^{cdef}	2.46^{bcdef}	14.83^{g}
ICFH-16	6.00	25.37^{ab}	7.06^{defg}	7.66^{bcdef}	2005.6^{cdef}	2.59^{cdef}	13.46f
ICFH-17	7.00	27.35^{ab}	7.32^{h}	8.16^{def}	2126.1^{ef}	3.14^{fg}	12.65^{ef}
ICFH-18	5.33	23.15^{ab}	6.83^{cde}	7.25^{abcde}	1857.7^{bcdef}	2.06^{abcd}	12.27^{de}
ICFH-19	5.00	22.19^{ab}	6.80^{c}	6.81^{abcd}	1738.1^{abcd}	1.62^{ab}	11.68^{bcde}
ICFH-20	6.33	26.23^{ab}	7.08^{fg}	7.92^{cdef}	2058.3^{def}	2.75^{def}	11.56^{bcde}
SEm±	1.70	5.59	0.13	0.75	176.33	0.49	0.58
CD (P=0.05)	NS	5.58	0.26	1.53	356.95	0.99	1.15

Values in table containing different superscripts are significantly different with each other.

parameters. Accessions ICFH-5, ICFH-2, ICFH-17, ICFH-6, ICFH-4, ICFH-20, ICFH-11, ICFH-16, ICFH-7, ICFH-15, ICFH-8, ICFH-18, ICFH-12 and ICFH-1 were at par to one another with respect to all the observed yield attributes. Our results are in close proximity with the findings of (Yadav *et al.,* 2004; Nariya *et al.,* 2005; Meena *et al.,* 2012).

Table 5. Pearson Correlation matrix (p<0.05%) between physiological attributes and yield

Variables	TCC	P	TSP	MI	EWC	TSS	R-K	R-Na	S-K	S-Na	DMY	GY
RWC	0.945	-0.821	0.956	-0.796	-0.818	-0.636	0.947	-0.745	0.855	-0.548	0.906	0.043
TCC		-0.792	0.916	-0.820	-0.747	-0.736	0.902	-0.716	0.763	-0.542	0.916	0.055
P			-0.921	0.977	0.934	0.890	-0.742	0.973	-0.826	0.641	-0.657	0.246
TSP				-0.889	-0.904	-0.770	0.887	-0.877	0.880	-0.558	0.840	-0.068
MI					0.903	0.936	-0.714	0.941	-0.778	0.613	-0.670	0.201
EWC						0.796	-0.709	0.903	-0.806	0.478	-0.659	0.141
TSS							-0.520	0.873	-0.601	0.477	-0.553	0.313
R-K								-0.670	0.829	-0.605	0.880	0.080
R-Na									-0.806	0.628	-0.590	0.314
S-K										-0.574	0.726	-0.112
S-Na											-0.416	0.245
DMY												0.149

*RWC-Relative water content, TCC-Total chlorophyll content, P-proline, TSP-Total soluble protein, MI-Membrane injury, EWC-Epicuticular wax content, TSS-Total soluble sugar, R-K-Root potassium, R-Na-Root Sodium, S-K-Shoot potassium, S-Na-shoot sodium, DMY-Dry matter yield and GY-grain yield

Yield

Grain yield was influenced significantly due to different accessions. It is explicit from data presented in table 4 that the maximum grain yield was recorded in accession ICFH-5 (3.68 Mg ha^{-1}) followed by ICFH-2 (3.14 Mg ha^{-1}), ICFH-17 (3.14 Mg ha^{-1}). The highest and lowest DM was attained in ICFH-15 (14.83 Mg ha^{-1}) and ICFH-07 (9.78 Mg ha^{-1}), respectively. Similar results for varying grain yields were reported in pearl millet by Khan *et al.* (2000) and Meena *et al.* (2012).

Correlation matrix

Association influences between physiological attributes and yield are presented in table 5. Results of correlation study showed that the highest positive correlation was observed with RWC and TSP (r=0.956). Highest negative relation was obtained between proline and TSP (r= -0.921).

In general, the positive correlation was seen under RWC, TCC, TSP, R-K, S-K and DMY. However, TCC and RWC have negative relation with MI, EWC and TSS. Among the physiological attributes TCC had highest positive correlation which revealed that Chlorophyll content imparts lush green colour to the fodder and improves radiation absorption and quality. That might the reason behind higher DMY as it provided stomata non-limiting condition. Negative correlation was seen between grain yield and TSP while grain yield had revealed the positive correlation with shoot potassium content.

Conclusions

Our results suggested that ICFH -15 to 17 are the best three accessions suitable for dry matter yield (Dry fodder purpose), while accessions ICFH-5, 2 and ICFH-17 for grain purpose, because these have more favourable physiological, biochemical and yield attributes resulting in higher DM and grain yield, respectively under saline conditions.

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