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Physiological and biochemical mechanisms associated with salinity tolerance in sorghum (*Sorghum bicolor* L.) under drip irrigation

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Abstract

Salinity is a major abiotic stress limiting crop productivity through osmotic stress, ionic imbalance and oxidative damage. Understanding the physiological and biochemical mechanisms underlying salinity tolerance is essential for identifying resilient genotypes suitable for cultivation under saline environments. A field experiment was conducted during *rabi*, 2025-26 to evaluate the physiological and biochemical responses of sorghum varieties subjected to different levels of irrigation water salinity under drip irrigation. The experiment comprised five irrigation water salinity levels Best Available Water (BAW), 3, 6, 9 and 12 dS m⁻¹ and three sorghum varieties (NTJ5, SVT 55 and SVT 68) arranged in a split plot design with three replications. Relative water content and chlorophyll concentration declined significantly with increasing salinity levels, whereas membrane injury increased. Salinity stress induced significant accumulation of proline content. Among the varieties, SVT 68 maintained higher relative water content, chlorophyll concentration, osmolyte accumulation and antioxidant activity, indicating superior physiological adaptation to salinity stress and variety NTJ 5 was statistically on comparable for these parameters.

Keywords: Sorghum, salinity stress, relative water content, proline, osmotic adjustment, drip irrigation

Introduction

Salinity is one of the most serious environmental constraints affecting agricultural productivity worldwide. The continuous use of saline groundwater for irrigation has increased the extent of salt-affected soils, particularly in arid and semi-arid regions. Excess salts in the root zone decrease water availability, disrupt nutrient uptake and induce oxidative stress, ultimately reducing crop growth and productivity.

Plants exposed to salinity activate several adaptive mechanisms including osmotic adjustment, antioxidant defense and ionic regulation. Accumulation of compatible solutes such as proline, phenols and soluble sugars helps maintain cell turgor and protect cellular structures. Similarly, antioxidant enzymes such as superoxide dismutase (SOD), peroxidase (POD) and catalase (CAT) detoxify reactive oxygen species generated under stress conditions.

Sorghum is considered moderately tolerant to salinity; however, varietal differences exist in physiological adaptation and stress tolerance. Therefore, understanding the physiological and biochemical responses of sorghum genotypes under saline irrigation is essential for developing effective management strategies and selecting tolerant varieties. The present study was undertaken to investigate the physiological and biochemical mechanisms associated with salinity tolerance in sorghum under drip irrigation.

Materials and Methods

A field experiment was conducted during *rabi*, 2025-26 at the Agricultural College Farm, Bapatla, Andhra Pradesh, using a split-plot design with three replications. The treatments comprised three sorghum varieties (NTJ 5, SVT 55, and SVT 68) as main plots and five irrigation water salinity levels Best Available Water (0.6 dS m⁻¹), 3, 6, 9, and 12 dS m⁻¹ as sub-plots. The experimental soil was sandy loam, neutral in reaction (pH 7.1) and non-saline (EC 0.7 dS m⁻¹), with low available N, medium P, and high K.

A fertilizer dose of N, P₂O₅, K₂O @ 100:60:40 kg ha⁻¹ was applied through urea, single superphosphate and muriate of potash respectively. Saline irrigation water was prepared by diluting seawater (38 dS m⁻¹) with fresh water (0.6 dS m⁻¹) and treatments were imposed from 20 DAS through a drip irrigation system scheduled at 100% pan evaporation (Epan) at three-day intervals.

Physiological and Biochemical Analysis

Total chlorophyll content was estimated by the DMSO extraction method using spectrophotometric readings at 645 and 663 nm (Hiscox and Israelstam, 1979) [14]. Relative water content (RWC) was determined following the method of Barrs and Weatherley (1962) [7], while membrane injury was estimated based on electrolyte leakage according to Towill and Mazur (1975) [35]. Proline content was determined by the acid ninhydrin method (Bates *et al.*, 1973) [8]. Plant samples were wet-digested using a nitric acid-perchloric acid mixture (9:4) and Na⁺ and K⁺ concentrations were determined using standard procedures described by Jackson (1973) [15] and Tandon (1999) [34]. Ionic ratios (Na⁺/K⁺) were calculated from the measured ion concentrations. Data were subjected to analysis of variance and treatment means were compared at the 5% level of significance.

Results and Discussion

Influence of Saline Water Irrigation on Grain and Stover Yield of Sorghum Varieties

Varieties, saline water irrigations and their interactions had marked influence on grain and stover yields. Among the sorghum varieties, variety NTJ-5 recorded significantly the highest grain yield (4822 kg ha⁻¹) and stover yield (8718 kg ha⁻¹), while SVT 68 recorded the lowest grain (3489 kg ha⁻¹) and stover (7971 kg ha⁻¹) yields. This superior performance of NTJ 5(V₁) was due to its better genetic potential, higher sink capacity, efficient photosynthate translocation, longer ear head length and heavier ear head weight, contributing to higher grain filling and productivity. Similar results were also reported by Sahar *et al.* (2024) [30], Jayalakshmi *et al.* (2024) [16]. Among salinity levels, Best Available Water (BAW) produced the highest grain (4716 kg ha⁻¹) and stover (8906 kg ha⁻¹) yields, remaining on par with 3 and 6 dS m⁻¹, whereas 12 dS m⁻¹ recorded the lowest grain (3167 kg ha⁻¹) and stover (7074 kg ha⁻¹) yields. Irrigation with BAW caused less osmotic stress on the crop and assisted in improving growth and yield and reduction in grain yield under elevated salinity stress was due to restricted water and nutrient uptake, reduced ear head weight, poor grain filling. Severe salinity adversely affects reproductive development, lowering productivity. These findings are in accordance with Chowdary *et al.* (2016) [10], Mageed *et al.* (2018) [21]. The interaction of variety NTJ-5 under BAW irrigation recorded the highest grain (5667 kg ha⁻¹) and stover (9667 kg ha⁻¹) yields, while variety SVT-68 and 12 dS m⁻¹ salinity level recorded the lowest grain (2870 kg ha⁻¹) and stover (6574 kg ha⁻¹) yields.

Relative Water Content (RWC)

Among the varieties, SVT 68 (V₃) recorded the highest RWC (82.9%), which was statistically on par with NTJ 5 (V₁), whereas SVT 55 (V₂) recorded the lowest RWC (72.0%). Among the salinity levels, BAW (S₁) recorded the highest RWC (86.8%), which was statistically comparable with 3 dS m⁻¹ (S₂) and 6 dS m⁻¹ (S₃) but significantly

superior to the higher salinity levels. The lowest RWC (61.4%) was observed under 12 dS m⁻¹ (S₅). The reduction in RWC with increasing salinity may be attributed to loss of cell turgor due to osmotic stress. Accumulation of solutes in plant cells facilitates osmotic adjustment, helping maintain cell volume and reduce water loss under saline conditions (Fahmy and Esmat, 2014) [12]. The interaction effect was significant, with the highest RWC (92.2%) recorded in SVT 68 (V₃) under BAW (S₁) and the lowest (52.4%) in SVT 55 (V₂) under 12 dS m⁻¹ (S₅). Similar findings were reported by Sarker and Oba (2020) [32] and Pattanagul and Thitisaksakul (2008) [27]. RWC is an important indicator of leaf survival and metabolic activity and is widely used to distinguish salt-tolerant and sensitive genotypes under salinity stress (Sinclair and Ludlow, 1986) [33].

Data showed significant variation in RWC at maturity among varieties, salinity levels, and their interaction. SVT 68 (V₃) recorded the highest RWC (72.3%), which was statistically comparable with NTJ 5 (V₁), whereas SVT 55 (V₂) recorded the lowest (62.4%). These genotypic differences in RWC reflect the interaction between genetic characteristics and environmental factors governing plant water retention (Dehnavi *et al.*, 2024) [11]. Among the salinity treatments, BAW (S₁) recorded the highest RWC (76.9%), which was statistically on par with 3 dS m⁻¹ (S₂) and 6 dS m⁻¹ (S₃), whereas the lowest RWC (50.1%) was observed under 12 dS m⁻¹ (S₅). The continuous decline in RWC with increasing salinity indicates reduced water uptake and loss of cellular turgor due to osmotic stress (Zhang *et al.*, 2022) [37]. The interaction effect was also significant, with the highest RWC (78.4%) recorded in SVT 68 (V₃) under BAW (S₁) and the lowest (40.0%) in SVT 55 (V₂) under 12 dS m⁻¹ (S₅). These findings agree with Ashraf *et al.* (2023) [6]. The relatively higher RWC in tolerant varieties may be attributed to greater osmotic adjustment, which lowers cellular osmotic potential, enhances root water uptake, and maintains cell turgidity under salt stress (Sarker and Oba, 2020) [32].

Membrane Injury

Among the varieties, NTJ 5 (V₁) recorded the lowest membrane injury (41.3%), which was statistically comparable with SVT 68 (V₃), while SVT 55 (V₂) recorded the highest (56.0%). The lower membrane injury in NTJ 5 and SVT 68 indicates better membrane stability under salt stress (Adilakshmi, 2016) [2]. Membrane injury increased progressively with salinity, with the lowest value (34.2%) under BAW (S₁), statistically at par with 3 dS m⁻¹ (S₂), and the highest (48.3%) under 12 dS m⁻¹ (S₅). This increase has been associated with enhanced H₂O₂ accumulation and electrolyte leakage under salt stress (Nawaz *et al.*, 2010; Kukreja *et al.*, 2006; Rani, 2004) [26, 19, 29]. The interaction effect was significant, with the lowest membrane injury (27.1%) in NTJ 5 (V₁) under BAW (S₁) and the highest (53.3%) in SVT 55 (V₂) under 12 dS m⁻¹ (S₅) (Munira *et al.*, 2015) [25].

Similarly, at maturity stage significant effects of varieties, salinity levels and their interaction on membrane injury was recorded. NTJ 5 (V₁) recorded the lowest membrane injury (36.8%), statistically on par with SVT 68 (V₃), whereas SVT 55 (V₂) recorded the highest (47.3%). Membrane injury increased from 35.3% under BAW (S₁) to 59.9% under 12 dS m⁻¹ (S₅). Higher electrolyte leakage under salinity reflects membrane damage caused by increased cell permeability and lipid peroxidation (Makarana *et al.*, 2019;

Feng *et al.*, 2003; Kumar *et al.*, 2015) [22, 13, 20]. The interaction effect was significant, with the lowest membrane injury (31.2%) in NTJ 5 (V₁) under BAW (S₁) and the highest (67.2%) in SVT 55 (V₂) under 12 dS m⁻¹ (S₅), in agreement with Sarker and Oba (2020) [32].

Chlorophyll Content

Total chlorophyll content at flowering was not significantly influenced by sorghum varieties. Numerically, SVT 68 (V₃) recorded the highest chlorophyll content (2.2 mg g⁻¹), while NTJ 5 (V₁) and SVT 55 (V₂) recorded the lowest (2.0 mg g⁻¹). Salinity levels significantly affected total chlorophyll content. The highest chlorophyll content (2.4 mg g⁻¹) was recorded under BAW (S₁), which was statistically comparable with 3 dS m⁻¹ (S₂) and significantly superior to the higher salinity levels, whereas the lowest value (1.9 mg g⁻¹) was observed under 12 dS m⁻¹ (S₅). The decline in chlorophyll content with increasing salinity may be attributed to chlorophyll oxidation by free radicals and disruption of pigment protein complexes by salt ions (Vahid *et al.*, 2011; Kato and Shimizu, 1985) [36, 17]. The interaction effect between varieties and salinity levels at flowering was non-significant.

At maturity, total chlorophyll content also did not differ significantly among varieties. However, SVT 68 (V₃) recorded the highest numerical value (1.7 mg g⁻¹), while SVT 55 (V₂) recorded the lowest (1.5 mg g⁻¹). Salinity significantly influenced chlorophyll content at maturity, with the highest value (2.0 mg g⁻¹) recorded under BAW (S₁), statistically on par with 3 dS m⁻¹ (S₂) and the lowest (1.2 mg g⁻¹) under 12 dS m⁻¹ (S₅). The reduction in chlorophyll under saline conditions may be due to disruption of chloroplast membrane integrity and oxidative degradation of chlorophyll pigments caused by excessive reactive oxygen species (Ahmad *et al.*, 2022) [3]. The interaction effect at maturity was significant. The highest chlorophyll content (2.1 mg g⁻¹) was recorded in SVT 68 (V₃) under BAW (S₁), whereas the lowest (1.1 mg g⁻¹) was observed in SVT 55 (V₂) under 12 dS m⁻¹ (S₅).

Proline Accumulation

Among the varieties, SVT 68 (V₃) recorded the highest proline content at flowering (327.9 µg g⁻¹), which was statistically on par with NTJ 5 (V₁) and superior to SVT 55 (V₂), which recorded the lowest value (264.5 µg g⁻¹). Similar results were reported by Makarana *et al.* (2019) [22] and Adilakshmi (2016) [2]. Proline content increased progressively with salinity, from 183.9 µg g⁻¹ under BAW (S₁), statistically comparable with 3 dS m⁻¹ (S₂), to 469.3 µg g⁻¹ under 12 dS m⁻¹ (S₅). Proline accumulation under salinity promotes osmotic adjustment, facilitates water

uptake, maintains cell turgidity, and protects cellular functions under stress (Abdelaziz *et al.*, 2014; Sairam *et al.*, 2002; Misra and Gupta, 2005) [1, 31, 24]. The interaction effect was significant, with the lowest proline content (178.8 µg g⁻¹) in SVT 55 (V₂) under BAW (S₁) and the highest (470.7 µg g⁻¹) in SVT 68 (V₃) under 12 dS m⁻¹ (S₅) (Bavei *et al.*, 2011) [9].

At maturity, SVT 68 (V₃) recorded the highest proline content (255.1 µg g⁻¹), statistically on par with NTJ 5 (V₁), while SVT 55 (V₂) recorded the lowest (218.0 µg g⁻¹), corroborating Alaei *et al.* (2020) [4]. Proline content increased from 154.2 µg g⁻¹ under BAW (S₁) to 305.6 µg g⁻¹ under 12 dS m⁻¹ (S₅). The increase may be attributed to the role of proline in scavenging reactive oxygen species and maintaining the integrity of cellular macromolecules under stress (Rahdari *et al.*, 2012; Koc *et al.*, 2010) [28, 18], as also reported by Bavei *et al.* (2011) [9]. The interaction effect was significant, with the lowest proline content (136.6 µg g⁻¹) in SVT 55 (V₂) under BAW (S₁) and the highest (329.7 µg g⁻¹) in SVT 68 (V₃) under 12 dS m⁻¹ (S₅).

Influence of Saline Water Irrigation on Na⁺/K⁺ Ratio

At flowering, the Na⁺/K⁺ ratio differed significantly among the sorghum varieties. SVT 55 (V₂) recorded the highest ratio (0.54), which was significantly superior to the other varieties, whereas SVT 68 (V₃) recorded the lowest ratio (0.45). Salinity significantly increased the Na⁺/K⁺ ratio, with the lowest value (0.39) recorded under BAW (S₁), which was statistically comparable with 3 dS m⁻¹ (S₂), and the highest (0.59) under 12 dS m⁻¹ (S₅). Increasing salinity reduced K⁺ concentration while enhancing Na⁺ accumulation, resulting in a higher Na⁺/K⁺ ratio, as reported by Vahid *et al.* (2011) [36]. Salt stress also promotes non-specific ion uptake, leading to greater Na⁺ accumulation in plant tissues (Anower-Rokebul *et al.*, 2013) [5]. The interaction between varieties and salinity levels at flowering was significant. The lowest Na⁺/K⁺ ratio (0.36) was observed in SVT 68 (V₃) under BAW (S₁), whereas SVT 55 (V₂) under 12 dS m⁻¹ (S₅) recorded the highest ratio (0.69).

At maturity, the Na⁺/K⁺ ratio did not differ significantly among the varieties, although SVT 55 (V₂) recorded the highest numerical value (0.79) and SVT 68 (V₃) the lowest (0.72). Salinity continued to increase the Na⁺/K⁺ ratio, from 0.64 under BAW (S₁), statistically comparable with 3 dS m⁻¹ (S₂), to 0.88 under 12 dS m⁻¹ (S₅). The increase was associated with greater Na⁺ accumulation and a decline in K⁺ concentration, in agreement with Menezes *et al.* (2017) [23]. Selective uptake of K⁺ over Na⁺ is considered a major physiological mechanism contributing to salt tolerance in plants. The interaction effect between varieties and salinity levels at maturity was not significant.

Table 1: Effect of saline water irrigation on grain and stover yields (kg ha⁻¹) of sorghum varieties

Varieties	Salinity levels (dS m ⁻¹)						Salinity levels (dS m ⁻¹)					
	S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC	Mean	S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC	Mean
V ₁ : NTJ-5	5667	5519	5007	4304	3611	4822	9667	9341	9018	7922	7640	8718
V ₂ : SVT-55	4370	4185	4085	3204	3018	3773	8852	8630	8334	7426	7007	8049
V ₃ : SVT-68	4111	3778	3667	3019	2870	3489	8200	7892	7796	7338	6574	7971
Mean	4716	4494	4253	3509	3167		8906	8621	8383	7579	7074	
	SEm (±)	CD (0.05)	CV (%)				SEm (±)	CD (0.05)	CV (%)			
MAIN PLOT	140	421	10.3				177.4	532	8.6			
SUB PLOT	192	576	14.7				246.4	738	9.1			
Interaction												
S at same level of V (S X V)	324	972					558	1675				
V at same or different level of S (V X S)	240	1020					565	1695				

Table 2: Effect of saline water irrigation on relative water content (%) of sorghum varieties at flowering and maturity stage

Varieties	Salinity levels (dS m ⁻¹)					Mean	Salinity levels (dS m ⁻¹)					Mean
	S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC		S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC	
V ₁ : NTJ-5	84.8	83.5	80.3	69.4	60.5	75.7	77.9	76.2	72.3	65.7	47.1	68.4
V ₂ : SVT-55	83.3	81.6	78.6	64.0	52.4	72.0	74.6	72.1	70.5	55.1	40.0	62.4
V ₃ : SVT-68	92.2	88.2	86.2	76.8	71.4	82.9	78.4	78.1	76.0	68.7	63.4	72.3
Mean	86.8	84.4	81.7	70.0	61.4		76.9	75.4	72.9	63.1	50.1	
	SEm (±)	CD (0.05)	CV (%)				SEm (±)	CD (0.05)	CV (%)			
MAIN PLOT	2.67	8.1	10.4				1.93	5.8	14.8			
SUB PLOT	1.94	5.7	7.6				1.51	4.5	6.3			
Interaction												
S at same level of V (S X V)	3.65	10.9					3.71	11.2				
V at same or different level of S (V X S)	4.63	13.8					6.33	18.9				

Table 3: Effect of saline water irrigation on membrane injury (%) of sorghum varieties at flowering and maturity stage

Varieties	Salinity levels (dS m ⁻¹)					Mean	Salinity levels (dS m ⁻¹)					Mean
	S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC		S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC	
V ₁ : NTJ-5	31.2	34.8	40.5	47.8	51.9	41.3	27.1	33.8	34.8	43.7	45.0	36.8
V ₂ : SVT-55	40.6	48.5	58.1	65.6	67.2	56.0	39.8	45.1	48.8	49.8	53.3	47.3
V ₃ : SVT-68	33.9	37.2	43.6	50.7	60.8	45.3	35.7	37.5	37.9	45.6	46.8	40.7
Mean	35.3	40.2	47.5	54.7	59.9		34.2	38.8	40.5	46.4	48.3	
	SEm (±)	CD (0.05)	CV (%)				SEm (±)	CD (0.05)	CV (%)			
MAIN PLOT	2.0	6.0	12.9				1.5	4.5	10.9			
SUB PLOT	1.2	3.6	7.8				1.6	4.8	11.4			
Interaction												
S at same level of V (S X V)	2.5	7.5					2.8	8.4				
V at same or different level of S (V X S)	3.5	10.5					2.7	8.1				

Table 4: Effect of saline water irrigation on total chlorophyll content (mg g⁻¹) of sorghum varieties at flowering and maturity stage

Varieties	Salinity levels (dS m ⁻¹)					Mean	Salinity levels (dS m ⁻¹)					Mean
	S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC		S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC	
V ₁ : NTJ-5	2.2	2.1	1.9	1.9	1.8	2.0	2.0	1.9	1.6	1.3	1.2	1.6
V ₂ : SVT-55	2.3	2.1	2.0	1.9	1.9	2.0	1.9	1.8	1.5	1.3	1.1	1.5
V ₃ : SVT-68	2.6	2.4	2.2	2.1	1.9	2.2	2.1	2.0	1.9	1.4	1.3	1.7
Mean	2.4	2.2	2.0	2.0	1.9		2.0	1.9	1.7	1.3	1.2	
	SEm (±)	CD (0.05)	CV (%)				SEm (±)	CD (0.05)	CV (%)			
MAIN PLOT	0.1	NS	12.8				0.1	NS	14.1			
SUB PLOT	0.1	0.3	10.3				0.1	0.3	12.2			
Interaction												
S at same level of V (S X V)	0.1	NS					0.1	0.3				
V at same or different level of S (V X S)	0.2	NS					0.1	0.3				

Table 5: Effect of saline water irrigation on proline content (µg g⁻¹) of sorghum varieties at flowering and maturity stage

Varieties	Salinity levels (dS m ⁻¹)					Mean	Salinity levels (dS m ⁻¹)					Mean
	S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC		S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC	
V ₁ : NTJ-5	185.4	206.7	281.7	399.7	424.3	299.6	150.0	192.0	252.0	272.0	294.2	232.0
V ₂ : SVT-55	178.8	189.0	220.0	322.0	413.0	264.5	136.6	182.0	210.1	268.4	293.0	218.0
V ₃ : SVT-68	187.4	254.3	300.7	426.3	470.7	327.9	176.0	206.1	264.4	299.1	329.7	255.1
Mean	183.9	216.7	267.4	382.7	469.3		154.2	193.3	242.2	279.8	305.6	
	SEm (±)	CD (0.05)	CV (%)				SEm (±)	CD (0.05)	CV (%)			
MAIN PLOT	11.9	35.7	12.3				9.3	27.9	11.5			
SUB PLOT	14.5	43.5	15.0				7.7	23.1	9.5			
Interaction												
S at same level of V (S X V)	24.3	72.9					13.9	41.7				
V at same or different level of S (V X S)							16.1	48.3				

Table 6: Effect of saline water irrigation on Na⁺/K⁺ ratio of sorghum varieties at flowering and maturity stage

Varieties	Salinity levels (dS m ⁻¹)					Mean	Salinity levels (dS m ⁻¹)					Mean
	S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC		S ₁ : BAW	S ₂ : 3 EC	S ₃ : 6 EC	S ₄ : 9 EC	S ₅ : 12 EC	
V ₁ : NTJ-5	0.37	0.41	0.48	0.52	0.55	0.47	0.65	0.69	0.78	0.83	0.85	0.76
V ₂ : SVT-55	0.45	0.47	0.51	0.58	0.69	0.54	0.65	0.72	0.79	0.86	0.96	0.79
V ₃ : SVT-68	0.36	0.40	0.47	0.50	0.53	0.45	0.62	0.64	0.71	0.77	0.84	0.72
Mean	0.39	0.42	0.49	0.53	0.59		0.64	0.68	0.76	0.82	0.88	
	SEm (±)	CD (0.05)	CV (%)				SEm (±)	CD (0.05)	CV (%)			
MAIN PLOT	0.02	0.06	10.5				0.03	NS	6.1			
SUB PLOT	0.02	0.06	11.2				0.02	0.06	7.0			
Interaction												
S at same level of V (S X V)	0.03	0.09					0.03	NS				
V at same or different level of S (V X S)	0.03	0.09					0.03	NS				

Conclusion

Significantly the highest grain and stover yields were recorded under variety NTJ 5 and pertaining to interaction variety NTJ 5 and BAW irrigation recorded highest grain and stover yields. Salinity significantly affected physiological and biochemical processes in sorghum. Increasing irrigation water salinity reduced relative water content, and chlorophyll concentration while increasing membrane injury. Salinity stress induced accumulation of proline and enhanced antioxidant enzyme activities. These responses contributed to osmotic adjustment and protection against oxidative damage. Among the tested varieties, SVT-68 exhibited superior physiological adaptation through better water status, membrane stability, osmolyte accumulation and antioxidant defense. Therefore, SVT-68 may be considered a physiologically tolerant genotype suitable for cultivation under saline irrigation conditions.

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