

Original Research Article

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## Biological Properties of Saline Soils Grown with Different Sorghum Cultivars

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### ABSTRACT

A pot culture experiment was conducted to study the biological properties of saline soils grown with different cultivars of sorghum during *rabi* 2015-2016 at Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla. Soils of different salinity (1.5, 5, 8 and 12 dS m<sup>-1</sup> of ECe) collected from Uppugundur region were tested using three cultivars (Hytech, Laxmi and Mahalaxmi) in completely randomized design with factorial concept replicating thrice. The salinity levels, cultivars and their interaction significantly influenced the microbial population and enzyme activity. Considerable reduction in microbial population and enzyme activity was observed at the maximum EC tested (12 dS m<sup>-1</sup>). The interaction between the salinity and cultivars at 30 DAS, flowering and harvest revealed that the bacterial population was highest (15.73, 18.50 and 16.33 X 10<sup>5</sup> CFU g<sup>-1</sup>) in the treatment combination of 1.5 dS m<sup>-1</sup> x Hytech and lowest (8.87, 10.64 and 9.66 X 10<sup>5</sup> CFU g<sup>-1</sup>) in the treatment combination 12 dS m<sup>-1</sup> x Mahalaxmi. Similar trends in fungal, actinomycetes population and dehydrogenase enzyme activity were recorded at 30 DAS, flowering and harvest stages.

#### Keywords

Electrical conductivity,  
Soil bacteria, Soil fungi,  
Soil actinomycetes and  
Dehydrogenase activity

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### Introduction

The microbial communities of the soil perform a fundamental role in cycling nutrients, in the organic matter content of soil and in maintaining plant productivity. Thus it is important to understand the microbial response to environmental stress, such as high concentrations of heavy metals of salts which is also known as saline stress which can gain importance, especially in agricultural soils where the high salinity may show a negative impact on soil physical, chemical, and biological properties and can ultimately

deteriorate soil quality in both ecological and agricultural aspects. Increase in salinity has shown a decrease in soil respiration rate and soil microbial biomass (Pathak and Rao, 1998). The reason for the reduced size and activity of the microbial community with increasing salinity is likely to be osmotic stress which is caused by large concentrations of salts in soil solutions (Oren, 1999). Osmotic stress usually limits microbial growth and activity in saline soil, while under sodic condition, ion toxicities and adverse pH conditions may also inhibit microbial growth (Rietz and Haynes, 2003). A decrease in

microbial activities with a rise in salinity is probably one of the reasons for poor crop growth in coastal saline soils (Trapathi *et al.*, 2006). The effect is always more pronounced in the rhizosphere according to the increase in water absorption by the plants due to transpiration. The simple explanation for this is that life in high salt concentrations has a high bio-energetic taxation, since the microorganisms need to maintain osmotic equilibrium between the cytoplasm and the surrounding medium, excluding sodium ions from inside the cell.

As a result, energy sufficient for osmo adaptation is required (Jiang *et al.*, 2007). Specific ion toxicities (e.g. those of Na and Cl) may also tend to inhibit microbial growth in saline soils (Zahran, 1997). The activity of exo-cellular enzymes involved in C ( $\beta$ -glucosidase) mineralization declined exponentially with increasing salinity (Rietz *et al.*, 2001).

## **Materials and Methods**

The experiment was conducted at Green House, Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla, by growing three sorghum cultivars (Hytech, Laxmi and Mahalaxmi) in soils of similar characteristics but variable salinity (1.5, 5, 8 and 12 dS m<sup>-1</sup> of ECe) collected from Uppugunduru region in a completely randomized design with factorial concept replicating thrice. Soil samples were collected at different stages of plant growth and are analysed for biological activity and other properties as per the following protocols.

### **Electrical conductivity (EC)**

The electrical conductivity in saturated extract (ECe) and in 1:2.5 soil water suspension was determined by using electrical conductivity bridge CM-180 (Jackson, 1973).

## **Enumeration of microbial population**

Bacteria, fungi and actinomycetes were estimated as per the procedures outlined by Paroda (2007).

### **Bacteria**

The enumeration of total bacteria in fresh soil samples was carried out by following serial dilution plate count technique (Dhingra and Sinclair, 2000) using nutrient agar medium (agar agar-20 g; beef extract-3 g; peptone-5 g; water – 1 litre).

Exactly 1g of soil was added to 10 mL of sterile water to dilute the population by 10 times, from which 0.1 mL was transferred to another 9.9 mL of sterile water and this dilution process was continued till 10<sup>5</sup> dilutions and 0.1 mL of the final diluted solution was transferred on to a petri plate with nutrient agar medium and spread with 'L' shaped glass rod and allowed it to grow for one and half day after which colony counts were recorded.

### **Fungi**

The enumeration of total fungi in the fresh soil samples of all treatments was carried out by following the standard serial dilution plate technique using Martins Rose Bengal Agar for fungi (Martin, 1950). The population was expressed in terms of colony forming units per g of soil (CFU g<sup>-1</sup> soil).

### **Actinomycetes**

The enumeration of total actinomycetes in the fresh soil samples of all treatments was carried out by following the standard serial dilution plate technique using Khusters Nutrient Agar medium. The population was expressed in terms of colony forming units per g of soil (CFU g<sup>-1</sup> soil).

### **Dehydrogenase activity**

Dehydrogenase activity in the soil sample was determined by following the procedure as described by Casida *et al.*, (1964).

## **Results and Discussion**

### **Soil electrical conductivity**

The EC values in 1: 2.5 soil water suspension of the initial soil used for the present experiment with E<sub>ce</sub> (saturation extract) of 1.5, 5, 8 and 12 dS m<sup>-1</sup> were 0.49, 1.39, 2.54 and 5.06 dS m<sup>-1</sup>, respectively (Table 1).

The electrical conductivity (1:2.5 soil water system) measured at different stages of crop growth *viz.*, 30 DAS, flowering and harvest (Table 1) revealed that, the EC values observed in different growth stages at variable levels of E<sub>ce</sub> were found to be more or less maintained at 30 DAS but later declined. However the EC (1:2.5 soil water system) followed an increasing trend with increase in E<sub>ce</sub> level at all growth stages. The decrease in EC values with advancement of the crop could be attributed to the leaching of salts to deeper layers (below 15 cm) due to the irrigation provided for successful growth of crop. Similar decrease in EC was also observed by Petersen (1996).

### **Influence of Salinity on biological properties of soil**

#### **Soil bacteria**

Data pertaining to soil bacterial population measured at different growth stages of crop *viz.*, 30 DAS, flowering and harvest as affected by salinity levels and different sorghum cultivars are presented in table 2. The soil bacterial population was significantly influenced by the salinity levels, varieties and their interaction.

The highest soil bacterial population (15.52 X 10<sup>5</sup> CFU g<sup>-1</sup>) at 30 DAS was recorded at the lowest salinity level of 1.5 dS m<sup>-1</sup>, which was found to be significant over the remaining salinity levels. The lowest soil bacterial population of 9.21 X 10<sup>5</sup> CFU g<sup>-1</sup> was recorded at the highest salinity level of 12 dS m<sup>-1</sup>. Similar trend of decrease in soil bacterial population with salinity was observed at flowering and harvest stages also with the highest (17.80 and 16.12 X 10<sup>5</sup> CFU g<sup>-1</sup>) and the lowest values (11.16 and 10.22 X 10<sup>5</sup> CFU g<sup>-1</sup>) recorded by 1.5 dS m<sup>-1</sup> and 12 dS m<sup>-1</sup> salinity levels, respectively. At all the three stages each level was significantly superior over the higher levels of salinity.

At 30 DAS, flowering and at harvest the highest bacterial population of 13.08, 15.01 and 13.40 X 10<sup>5</sup> CFU g<sup>-1</sup>, respectively was observed with cultivar Hytech whereas, the lowest bacterial population of 12.05, 13.57 and 12.79 X 10<sup>5</sup> CFU g<sup>-1</sup>, respectively was observed with cultivar Mahalaxmi.

The interaction effect of salinity and cultivars on bacterial population was significant and the highest bacterial population was recorded in the treatment combination of 1.5 dS m<sup>-1</sup> X Hytech (15.73, 18.50 and 16.33 X 10<sup>5</sup> CFU g<sup>-1</sup>) at 30 DAS, flowering and harvest stages whereas, the lowest bacterial population (8.87, 10.64 and 9.66 X 10<sup>5</sup> CFU g<sup>-1</sup>) was recorded by the treatment combination 12 dS m<sup>-1</sup> X Mahalaxmi at all stages of crop growth, respectively.

#### **Soil fungi**

The soil fungal population was significantly influenced by the salinity levels, varieties and their interaction.

The data related to soil fungi (Table 3) revealed a significant decrease in fungal population with increase in salinity from 1.5

dS m<sup>-1</sup> to 12 dS m<sup>-1</sup> at all growth stages. The highest soil fungal population of 10.82, 11.61 and 11.03 X 10<sup>3</sup> CFU g<sup>-1</sup> was recorded at 30 DAS, flowering and harvest, respectively with the lowest salinity level of 1.5 dS m<sup>-1</sup>, which was found to be significant over the remaining salinity levels. The lowest soil fungal population at all growth stages (7.12, 8.76 and 7.96 X 10<sup>3</sup> CFU g<sup>-1</sup>, respectively at 30 DAS, flowering and harvest was recorded at higher salinity level of 12 dS m<sup>-1</sup>.

Regarding the cultivars tested, the Hytech cultivar resulted in a significantly higher fungal population over others at all growth stages. The cultivar Laxmi recorded intermediate values at all the stages and it showed a significant effect over Mahalaxmi at early stages but was comparable at harvest. The lowest fungal population was recorded by the cultivar Mahalaxmi at all stages of the crop growth.

The critical observation of data indicated that, the interaction effect of salinity and cultivars was significant on fungal population. The highest fungal population at all growth stages was recorded by the treatment combination 1.5 dS m<sup>-1</sup> x Hytech while the lowest population was recorded by the treatment combination 12 dS m<sup>-1</sup> x Mahalaxmi.

### **Soil actinomycetes**

Data pertaining to soil actinomycetes population (X 10<sup>4</sup> CFU g<sup>-1</sup>) revealed a significant influence of salinity levels, varieties and their interaction are presented in table 4. In general the soil actinomycetes population decreased with increasing salt concentration.

At 30 DAS the highest soil actinomycetes population of 15.03 X 10<sup>4</sup> CFU g<sup>-1</sup> was recorded at the lowest salinity level of 1.5 dS m<sup>-1</sup>, which was found to be significant over

the remaining salinity levels. The lowest soil actinomycetes population of 9.17 X 10<sup>4</sup> CFU g<sup>-1</sup> was recorded at higher salinity level of 12 dS m<sup>-1</sup>. Similar trend of decrease in soil actinomycetes population with salinity was observed at flowering and harvest. From the data, it can be inferred that the per cent reduction in soil actinomycetes population from the lowest salinity level to the highest salinity level (1.5 dS m<sup>-1</sup> to 12 dS m<sup>-1</sup>) was 38.99, 34.33 and 28.93 at 30 DAS, flowering and harvest, respectively.

At 30 DAS, flowering and at harvest the highest actinomycetes population of 12.70, 14.15 and 13.51 X 10<sup>4</sup> CFU g<sup>-1</sup>, respectively was observed with cultivar Hytech (V<sub>1</sub>) whereas, the lowest actinomycetes population of 12.06, 13.85 and 12.63 X 10<sup>4</sup> CFU g<sup>-1</sup>, respectively was observed with cultivar Mahalaxmi but at flowering the highest actinomycetes population of 14.15 X 10<sup>4</sup> CFU g<sup>-1</sup> was observed with cultivar Hytech. The lowest actinomycetes population was recorded by the cultivar Mahalaxmi at all stages of the crop growth.

The interactions revealed that the highest actinomycetes population was recorded in treatment combination of 1.5 dS m<sup>-1</sup> x Hytech at all growth stages. This treatment combination was found to be at par with 1.5 dS m<sup>-1</sup> x Laxmi at 30 DAS and harvest and with 1.5 dS m<sup>-1</sup> X Laxmi and 1.5 dS m<sup>-1</sup> x Mahalaxmi at flowering and all other treatment combinations were inferior to other treatments. At all stages the lowest was recorded with Mahalaxmi at the highest salinity.

The perusal of data indicated that all groups of microbes studied were sensitive to salinity. However the population of microbes was found to be maximum at flowering due to active plant growth, which results in high root exudation.

**Table.1** Electrical conductivity (dS m<sup>-1</sup>) in 1:2.5 soil water system of soils at 30 DAS, flowering and at harvest stage

Salinity levels (dS m <sup>-1</sup> )		Electrical conductivity (dS m <sup>-1</sup> ) at 30 DAS				Electrical conductivity (dS m <sup>-1</sup> ) at flowering stage				Electrical conductivity (dS m <sup>-1</sup> ) at harvest stage			
ECe	EC (1:2.5)	Sorghum cultivars				Sorghum cultivars				Sorghum cultivars			
		V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean
S <sub>1</sub> (1.5)	0.49	0.49	0.44	0.42	0.45	0.25	0.20	0.24	0.23	0.14	0.16	0.20	0.17
S <sub>2</sub> (5)	1.39	1.36	1.26	1.15	1.26	1.20	0.98	1.11	1.10	1.00	1.02	0.99	1.00
S <sub>3</sub> (8)	2.54	2.37	2.26	2.25	2.29	2.20	2.27	2.27	2.25	2.26	2.20	2.20	2.22
S <sub>4</sub> (12)	5.06	4.38	4.43	4.92	4.58	4.30	4.20	4.07	4.19	4.08	4.17	4.05	4.10
Mean		2.15	2.10	2.19		1.99	1.91	1.92		1.87	1.89	1.86	
		SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%	
Factor S		0.03	0.08	3.95		0.03	0.08	4.02		0.02	0.05	2.48	
Factor V		0.02	NS			0.02	NS			0.01	NS		
S X V		0.05	0.14			0.05	0.13			0.03	0.08		

**Table.2** Soil bacterial population (CFU g<sup>-1</sup> X 10<sup>5</sup>) as influenced by salinity and sorghum cultivars

Salinity levels (dS m <sup>-1</sup> )	Soil bacterial population (CFU g <sup>-1</sup> X 10 <sup>5</sup> ) at 30 DAS				Soil bacterial population (CFU g <sup>-1</sup> X 10 <sup>5</sup> ) at flowering stage				Soil bacterial population (CFU g <sup>-1</sup> X 10 <sup>5</sup> ) at harvest stage			
	Sorghum Cultivars				Sorghum Cultivars				Sorghum Cultivars			
	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean
S <sub>1</sub> (1.5)	15.73	15.63	15.20	15.52	18.50	18.19	16.71	17.80	16.33	16.03	16.00	16.12
S <sub>2</sub> (5)	14.20	13.85	13.61	13.89	16.21	15.04	13.87	15.04	14.28	14.09	13.96	14.11
S <sub>3</sub> (8)	12.87	11.87	10.53	11.76	13.74	13.71	13.04	13.50	12.33	12.00	11.53	11.95
S <sub>4</sub> (12)	9.54	9.22	8.87	9.21	11.58	11.27	10.64	11.16	10.66	10.33	9.66	10.22
Mean	13.08	12.64	12.05		15.01	14.55	13.57		13.40	13.11	12.79	
	SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%	
Factor S	0.15	0.44	3.63		0.13	0.39	2.79		0.06	0.19	1.47	
Factor V	0.13	0.39			0.12	0.34			0.06	0.16		
S X V	0.26	0.77			0.23	0.68			0.11	0.32		

**Table.3** Soil fungal population (CFU g<sup>-1</sup> X 10<sup>3</sup>) as influenced by salinity and sorghum cultivars

Salinity levels (dS m <sup>-1</sup> )	Soil fungal population (CFU g <sup>-1</sup> X 10 <sup>3</sup> ) at 30 DAS				Soil fungal population (CFU g <sup>-1</sup> X 10 <sup>3</sup> ) at flowering stage				Soil fungal population (CFU g <sup>-1</sup> X 10 <sup>3</sup> ) at harvest stage			
	Sorghum Cultivars				Sorghum Cultivars				Sorghum Cultivars			
	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean
S <sub>1</sub> (1.5)	11.53	10.50	10.44	10.82	12.52	11.51	10.79	11.61	11.69	10.92	10.49	11.03
S <sub>2</sub> (5)	10.35	9.47	8.98	9.60	11.44	11.02	10.44	10.97	10.06	10.01	9.93	10.00
S <sub>3</sub> (8)	8.49	8.11	7.40	8.00	9.45	9.17	9.09	9.24	9.83	8.35	8.16	8.78
S <sub>4</sub> (12)	7.87	7.12	6.36	7.12	8.93	8.90	8.44	8.76	8.07	7.92	7.89	7.96
Mean	9.56	8.80	8.30		10.59	10.15	9.69		9.91	9.30	9.12	
	SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%	
Factor S	0.07	0.20	2.27		0.10	0.31	3.10		0.12	0.34	3.68	
Factor V	0.06	0.17			0.09	0.27			0.10	0.29		
S X V	0.12	0.34			0.18	0.53			0.20	0.58		

**Table.4** Soil actinomycete population (CFU g<sup>-1</sup> X 10<sup>4</sup>) as influenced by salinity and sorghum cultivars

Salinity levels (dS m <sup>-1</sup> )	Soil actinomycete population (CFU g <sup>-1</sup> X 10 <sup>4</sup> ) at 30 DAS				Soil actinomycete population (CFU g <sup>-1</sup> X 10 <sup>4</sup> ) at flowering stage				Soil actinomycete population (CFU g <sup>-1</sup> X 10 <sup>4</sup> ) at harvest stage			
	Sorghum Cultivars				Sorghum Cultivars				Sorghum Cultivars			
	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean
S <sub>1</sub> (1.5)	15.25	15.04	14.80	15.03	17.15	17.03	16.96	17.04	16.00	15.33	14.74	15.35
S <sub>2</sub> (5)	14.16	13.87	13.60	13.88	14.97	14.90	14.81	14.89	14.59	14.35	13.85	14.26
S <sub>3</sub> (8)	11.70	11.20	11.05	11.32	13.00	12.92	12.83	12.92	12.24	11.96	11.32	11.84
S <sub>4</sub> (12)	9.68	9.04	8.78	9.17	11.46	11.31	10.79	11.19	11.23	10.90	10.61	10.91
Mean	12.70	12.29	12.06		14.15	14.04	13.85		13.51	13.13	12.63	
	SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%		SEm±	CD (0.05)	CV%	
Factor S	0.04	0.12	1.01		0.05	0.15	1.07		0.05	0.15	1.17	
Factor V	0.04	0.11			0.04	0.13			0.04	0.13		
S X V	0.07	0.21			0.09	0.25			0.09	0.26		

**Table.5** Soil dehydrogenase enzyme activity ( $\mu\text{g TPF g}^{-1} \text{ day}^{-1}$ ) as influenced by salinity and sorghum cultivars

Salinity levels (dS m <sup>-1</sup> )	Soil dehydrogenase enzyme activity ( $\mu\text{g TPF g}^{-1} \text{ day}^{-1}$ ) at 30 DAS				Soil dehydrogenase enzyme activity ( $\mu\text{g TPF g}^{-1} \text{ day}^{-1}$ ) at flowering stage				Soil dehydrogenase enzyme activity ( $\mu\text{g TPF g}^{-1} \text{ day}^{-1}$ ) at harvest stage			
	Sorghum cultivars				Sorghum cultivars				Sorghum cultivars			
	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean	V <sub>1</sub> (Hytech)	V <sub>2</sub> (Laxmi)	V <sub>3</sub> (Mahalaxmi)	Mean
<b>S<sub>1</sub> (1.5)</b>	15.63	13.96	12.77	14.12	29.48	28.28	25.28	27.68	21.82	21.32	21.23	21.46
<b>S<sub>2</sub> (5)</b>	10.92	9.61	8.46	9.66	25.84	25.28	24.98	25.36	21.44	19.42	16.22	19.03
<b>S<sub>3</sub> (8)</b>	7.61	7.21	6.81	7.21	19.90	19.32	18.95	19.39	14.74	14.42	13.92	14.36
<b>S<sub>4</sub> (12)</b>	5.18	4.00	3.00	4.06	16.80	16.46	16.15	16.47	11.04	10.77	10.27	10.69
<b>Mean</b>	9.84	8.70	7.76		23.00	22.33	21.34		17.26	16.48	15.41	
	<b>SEm±</b>	<b>CD (0.05)</b>	<b>CV%</b>		<b>SEm±</b>	<b>CD (0.05)</b>	<b>CV%</b>		<b>SEm±</b>	<b>CD (0.05)</b>	<b>CV%</b>	
<b>Factor S</b>	0.10	0.30	3.57		0.29	0.86	3.98		0.20	0.59	3.67	
<b>Factor V</b>	0.09	0.26			0.26	0.74			0.17	0.51		
<b>S X V</b>	0.18	0.53			0.51	1.49			0.35	1.01		

Several root exudates are the carbon compounds like sugars, amines etc which act as food for organisms.

Study conducted by Matsuguchi and Sakai (1995) at different salinity levels revealed that all microbial populations may not be affected similarly by salinity stress. Some increase in number while, others follow a declining trend. The detrimental effect of salinity on the activity of microbial population (bacteria, fungi and actinomycetes) could be due to the manipulation of growth of living cells either by disrupting the normal physiological activities or intracellular macromolecular structures (Vogel *et al.*, 2010). The decline in microbial population could also be due to increase in salt concentration, which decreased osmotic potential and lead to reduction in activity of surviving cells (Ibekwe *et al.*, 2010). Similar results were reported by Wichern *et al.*, (2006).

The high influence of salinity on fungi was also reported earlier and was attributed to genetic diversity (Van and Semenov, 2000) and cell damage by the low osmotic potential (Hagemann, 2011).

### **Dehydrogenase enzyme activity**

Data pertaining to soil dehydrogenase activity measured at different growth stages of crop *viz.*, 30 DAS, flowering and harvest as affected by salinity levels in different sorghum cultivars are presented in table 5. The soil dehydrogenase activity was significantly influenced by the salinity levels, varieties and their interaction.

In general the dehydrogenase activity decreased with increasing salt concentration and degree of reduction varied with the salinity levels. At 30 DAS, flowering and at harvest the highest dehydrogenase activity of 14.12, 27.68 and 21.46  $\mu\text{g TPF g}^{-1} \text{day}^{-1}$ ,

respectively was recorded at the lowest salinity level of 1.5  $\text{dS m}^{-1}$ , which was found to be significant over the remaining salinity levels. The lowest dehydrogenase activity of 4.06, 16.47 and 10.69  $\mu\text{g TPF g}^{-1} \text{day}^{-1}$ , was recorded at higher salinity level of 12  $\text{dS m}^{-1}$  at 30 DAS flowering and at harvest, respectively. At all the three stages each level was significantly superior over the higher levels of salinity. From the data, it can be inferred that the per cent reduction in soil dehydrogenase activity from the lowest salinity level to the highest salinity level was 71.25, 40.50 and 50.19 at 30 DAS, flowering and harvest, respectively.

At all stages of crop growth the highest dehydrogenase activity of 9.84, 23.00 and 17.26  $\mu\text{g TPF g}^{-1} \text{day}^{-1}$  was observed with cultivar Hytech whereas, the lowest dehydrogenase activity of 7.76, 21.34 and 15.41  $\mu\text{g TPF g}^{-1} \text{day}^{-1}$  was observed with cultivar Mahalaxmi but at flowering the highest dehydrogenase activity of 23.00  $\mu\text{g TPF g}^{-1} \text{day}^{-1}$  was observed with cultivar Hytech. The sorghum cultivar Hytech, maintained the higher dehydrogenase activity at all stages of the crop growth whereas, the lowest was recorded by the cultivar Mahalaxmi at all stages of the crop growth.

The interactions revealed that the highest dehydrogenase activity was recorded in treatment combination 1.5  $\text{dS m}^{-1}$  x Hytech at all growth stages and all other treatment combinations were inferior to 1.5  $\text{dS m}^{-1}$  x Hytech. At all stages the lowest was recorded with Mahalaxmi at the highest salinity 12  $\text{dS m}^{-1}$  x Mahalaxmi.

The decline in enzyme activity with increasing salinity appeared to be associated with change in osmotic potential of the soil due to higher salt concentrations, specific ion toxicities and salting out effect of soluble salts on enzyme protein (Iftikhar and Khan, 1988).

An excessive content of easily-soluble inorganic salts in soil has a negative effect on the changes in the conformation of enzymatic protein which results in a decrease in its catalytic activity (Siddikee *et al.*, 2011).

Salinity levels and sorghum cultivars affected the soil biological activity. Soils of high salinity (12 dS m<sup>-1</sup>) were deprived of all the biological properties of soil. The cultivar Hytech maintained better soil properties at all stages of crop growth compared to Laxmi and Mahalaxmi.

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