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# Effect of Polyamine on Physio-Morphological Traits in Sugarcane Grown under Sodic Soil

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**A B S T R A C T**

The present investigation entitled with "Polyamine effect on biochemical events in sugarcane grown on sodic soils" was carried out to study the efficacy of polyamines viz., putrescine and spermidine to ameliorate the effect of soils sodicity by estimating the seedling height, root length of seedling, relative leaf water content, membrane injury index. The leaves of the two sugarcane cultivars viz., the salt tolerant CoM 0265 and salt susceptible CoC 671 grown on sodic soils and polyamines were applied at 0, 100 and 500µM concentration. The two foliar application of these polyamines were carried out 45 days after planting with 8 days interval. The leaf samples were collected after 65 days after planting for further studies. The study revealed that seedling height, root length of seedling, RLWC and chlorophyll a, b and total chlorophyll decreased significantly in both the varieties of sugarcane when grown in sodic soils. However, by the application of putrescine and spermidine, the effect of sodicity was relieved. The effect of 500µM of both polyamines was promising. The values of membrane injury index and lipid peroxidation were higher in the sugarcane leaves in both varieties when grown in sodic soils. The lipid peroxidation was found to be greatly affected by soil sodicity than the MII with the application of putrescine and spermidine the effect of sodicity was reversed in both the cultivars.

## Introduction

Sugarcane is one of the important crop of Maharashtra and India. India is the second position in area, production and productivity in the world next to Brazil. India's contribution to the world is about 19 per cent. In 2015-16, area in India was 4.927 Mha; production 348.48 million tones and productivity 70720 kg/ha (Indiastat, 2015). Salinization is one of the most devastating forms of land degradation threatening food production worldwide, especially in arid and semi-arid countries. However, climate change predictions indicated less rainfall and higher temperatures in the future in most of the agricultural regions. So, experts worry that the changes will lead to even more saline lands and predict that salinity will be increased from 4 to 9 $dSm^{-1}$ in the future. Progress in developing salt tolerant varieties has been very slow because of less knowledge on the mechanism of salt damage and complex nature of salt tolerance. Thus, understanding the adaptive mechanisms of each crop becomes necessary to improve or produce the salt resistant genotypes. Salinity may cause damage to the plants through osmotic stress, nutrient imbalance and specific ion toxicity (Munns*et al.,* 1986).

Sodicity represents the amount of exchangeable sodium (Na+) in water and in soil. Sodicity in soils has a strong influence on the soil structure. Dispersion occurs when the clay particles swell strongly and separate from each other on wetting. On drying, the soil becomes dense, cloddy, and without structure (Charters, 1993 and Sumner *et al*., 1998). Sodic soils have a pH 8.2 and a preponderance of carbonate and sodium by bicarbonate (Richards, 1954).

Polyamines (PAs), including the spermidine, spermine and putrescine are now regarded as plant growth regulators and secondary messenger in signaling pathways (Kusano *et al.,* 2008). Because of their cationic nature at physiological pH, PAs are able to interact with proteins, nucleic acids, membrane phospholipids and cell wall constituents, there by stabilizing these molecules. PAs have been reported to be involved in defense response to biotic and abiotic stresses (Alcázar *et al.,* 2010). Exogenously applied PAs have been reported to substantially enhance salt tolerance in rice plants (Chattopadhyay *et al.,* 2002).

Polyamines (PAs) are ubiquitous low-molecular-weight aliphatic amines that are involved in regulation of plant growth and development. PAs are also implicated in a wide range of environmental stress tolerance in plants. New roles are being discovered every day for these interesting molecules in the plant world. In higher plants, the most common PAs are spermidine (Spd) their diamine obligate precursor putrescine (Put). Like PAs displaying high biological activity are involved in a wide array of fundamental processes in plants, such as replication and gene expression, growth and development, senescence, membrane stabilization, enzyme activity modulation and adaptation to abiotic stresses (Hussain *et al.,* 2011; Alet *et al.,* 2012).

However, the precise physiological function and mechanism of action of PAs still remain unclear. It has been reported that exogenous application of PAs could alleviate salt induced reduction in photosynthetic efficiency, but this effect is strongly dependent both on PAs concentration or types and stress levels (Duan *et al.*, 2008). The result obtained by Zhang *et al.,* (2009) suggested that Put strongly affects photosynthetic apparatus involving in enhancement of photochemical quenching rather than regulation of stomatal closure or opening. Several publications have reported that changes of endogenous PA level and forms are involved in regulating the photochemical efficiency of salt-stressed plants, and PAs metabolism-related enzymes are closely correlated with photosynthesis.

The plants growing under salt stress or water deficit conditions have been investigated in many plants such as rice (Castillo *et al.,* 2007) and sugarcane (Pagariya *et al.,* 2011). Plant responses to salt stress are complex involving many genetic networks and metabolic processes and these depend on the inherent salt tolerance of the plant, concentration of salt and the duration of exposure (Munns and Tester, 2008). Plant adaptations to salinity are of three distinct types: osmotic stress tolerance; $Na^+$ exclusion; and tissue tolerance, that is, tolerance of tissue to accumulated $Na^+$, possibly $Cl^-$ (Munns and Tester, 2008).

Therefore overall aim of this study is to elucidate the polyamine induced physiological and biochemical changes responsible for induction of sodicity tolerance in sugarcane.

## Materials and Methods

### Experimental details

The sugarcane sets of a salt tolerant *viz*., CoM 0265 and a salt susceptible CoC 671 were obtained from CSRS Padegaon. The sets with an eye bud were washed and sterilized with sodium hypochlorite (0.1% w/v). The sets were dipped in the solution of individual polyamines *viz*., 0, 100 and 500µM of putrescine and spermidine. These setts were planted in sodic soil and normal soil in triplicate. The two foliar applications of these polyamines were carried out 45 days after planting with 8 days interval. The leaf samples were collected after 65 days after planting for the biochemical analyses. The seedling height, root length of seedling, relative leaf water content and membrane injury index were measured.

### Seedling height

The shoot lengths measured for each plant by using measuring tape.

### Root length of seedling

The process of removing the soil from the roots was performed for each plant. The root lengths were measured for each plant immediately after they had been washed thoroughly.

### Relative leaf water content

Relative leaf water content (RLWC) was estimated by the method described by Molaei*et al.*, (2012), from the leaf tissues of sugarcane grown in normal and sodic soils. The third leaf from the top of the main stem was detached from 5 randomly selected plants and kept in sealable plastic bag in an ice box. The leaf samples were brought to a laboratory where fresh weight was recorded immediately.

The leaf samples were then immediately hydrated to full turgidity for 2 hours by floating on de-ionized water in a close petri-dish under room temperature. After 2 hours the samples were taken out of water and water was removed were with a filter paper. It was immediately weighed to obtain fully turgid weight (TW). Samples were then dried at 80°C for 36 h and dry weight (DW) was determined. The RLWC was calculated by using the following formula.

$$\text{RWC \%} = \frac{(FW - DW)}{(TW - DW)} \times 100$$

### Membrane injury index (MII)

Membrane injury index was determined by method described by Molaei *et al.*, (2012), from the sugarcane leaves of the sugarcane grown in normal soil and sodic soils. For determination of cell membrane stability (CMS), 20 leaf pieces (2 cm each) of plants were washed with distilled water to remove the solution from the injured cells and tissue particles.

After which the samples were immersed in 20 mL distilled water at room temperature. After 24 h, the conductivity of the solutions was determined. The samples were autoclaved for 15 min, cooled to room temperature and the conductivity of the solutions was read again. The electrolyte leakage was measured with a conductometer. Membrane injury index was estimated from the formula:

$$\text{MII (\%)} = 1 - \frac{[1-(T_1/T_2)]}{[1-(C_1/C_2)]} \times 100$$

Where, T and C refer to values for the treated and control samples, while subscripts 1 and 2 are the initial and final conductivity readings, respectively.

## Results and Discussion

### Seedling height

The sugarcane cultivars grown in sodic soils caused significant reduction in the seedling height (Table 1). However, seedling height was more in salt tolerant cultivar CoM 0265 than salt susceptible CoC 671 grown in normal and sodic soils. The results of effect of polyamine on seedling height of sugarcane grown under normal and sodic soils revealed that there was significant increase in seedling height in both the cultivars with increase in the polyamine concentration under normal and sodic soil (Table 1). The seedling height of the tolerant variety CoM 0265 with the application of putrescine and spermidine was 11.2 cm (0µM), 11.9 cm (100µM), 12.7 cm (500µM) and 10.8 cm (0µM), 11.2 cm (100µM), 11.6 cm (500µM) respectively in normal soil. The seedling height of the variety CoM 0265 with the application of putrescine and spermidine was 9.8 cm (0µM), 10.7 cm (100µM), 11.8 cm (500µM) and 9.6 cm (0µM), 10.4 cm (100µM), 11.0 cm (500µM), respectively in sodic soil. The seedling height of the variety CoC 671 with the application of putrescine and spermidine was 7.2 cm (0µM), 8.5 cm (100µM), 10.2 cm (500µM) and 7.3 cm (0µM), 8.2 cm (100µM), 8.9 cm (500µM) respectively in normal soil. The seedling height of the variety CoC 671 with the application of putrescine and spermidine was 7.0 cm (0µM), 10.2 cm (100µM), 13.2 cm (500µM) and 7.0 cm (0µM), 8.5 cm (100µM), 10.3 cm (500µM) respectively in sodic soil. The interaction effect between the varieties and type of polyamine (V * T) was found to be significant. All other interactions were also found to be significant in the present study.

Growth reduction under salinity stress in terms of seedling height due to accumulation of the toxic saline ions at formative stage has been earlier reported in sugarcane (Wahid and Ghazanfar, 2006). Agarwal and Pandey (2004) reported that the NaCl treatment to *Cassia angustifolia* seedlings for 5 and 7 DAS resulted in a significant reduction in the seedling height. Amri *et al.*, (2011) and Amri and Shahsavar (2010) studied the effect of polyamines on pomegranate and lime under salinity and drought condition respectively. It was reported that under salinity and drought stress seedling height in pomegranate and lime was decreased.

### Root length of seedling

Sugarcane varieties grown in sodic soil resulted in significant reduction in root length in both the cultivars (Table 2). The reduction was more in salt susceptible cultivar CoC 671 than salt tolerant CoM 0265. Effect of polyamine on root length of seedling sugarcane grown under normal and sodic soils, revealed that there was decrease in root length of seedling with increase in the polyamine concentration under normal and sodic soils in both the cultivar (Table 2). The root length of seedling of the variety CoM 0265 by the application of putrescine and spermidine was 6.2 cm (0µM), 6.8 cm (100µM), 7.6 cm (500µM) and 6.1 cm (0µM), 6.5 cm (100µM), 6.9 cm (500µM) respectively in normal soil. The root length of seedling of the variety CoM 0265 with the application of putrescine and spermidine was 5.5 cm (0µM), 6.1 cm (100µM), 7.0 cm (500µM) and 5.7 cm (0µM), 6.3 cm (100µM), 6.6 cm (500µM) respectively in sodic soil.

The root length of seedling of the variety CoC 671 with the application of putrescine and spermidine was 6.0 cm (0µM), 6.9 cm (100µM), 8.0 cm (500µM) and 6.2 cm (0µM), 6.6 cm (100µM), 7.5 cm (500µM) respectively in normal soil. The root length of seedling of the variety CoC 671 with the application of putrescine and spermidine was 4.9 cm (0µM), 6.3 cm (100µM), 7.5 cm (500µM) and 5.0 cm (0µM), 6.1 cm (100µM), 7.1 cm (500µM) respectively in sodic soil.

All the interaction effects were found to be significant. The most common salinity effect is a general stunting of plant growth. As salt concentration increases above a threshold level both the growth rate and size of most plant species progressively decrease but all the plant parts are not affected equally. Root growth is often suppressed more than the shoot growth (Meiri and Poljakoff-Mayber, 1970). Salinity and water stress have quite similar effects on the growth and cell viability (Lutts*et al.*, 2004). Salinity causes pronounced decrease in water uptake and plant growth in shoot and root (Misra and Dwivedi, 2004). Agarwal and Pandey (2004) reported that the NaCl treatment of seedlings for 5 and 7 DAS resulted in a significant reduction in the root length. Similar trend was observed in the present investigation exogenous application of putrescine and spermidine to pomegranate seedling under salinity stress condition revealed that these polyamines caused to increase the longitudinal root length under salinity stress. However, putrescine showed the significantly superior results in respect of longitudinal root length under salinity condition than the spermidine (Amri *et al.*, 2011). Similarly, Amri and Shahsavar (2010) studied the effect of foliar application of spermidine on lime against drought stress and reported that root length was increased with application spermidine under drought stress however, without application of spermidine it decreased under drought stress condition. Furthermore, exogenous application of spermidine also has been reported to be effective in enhancing rice growth under saline condition (Saleethong *et al.*, 2011; Roychoudhury *et al.*, 2011). Chunthaburee *et al.*, (2014) observed improved root length in rice cultivars with priming of spermidine under salt stress condition. Similar results are obtained in the present investigation.

## Relative leaf water content

The sugarcane cultivars grown under normal and sodic soil resulted in decrease in RLWC when grown in sodic soil (Table 3). The pronounce decrease was observed in salt susceptible cultivar CoC 671 than the salt tolerant cultivar CoM 0265. It was observed that RLWC of sugarcane grown under normal and sodic soil was increased with increase in the polyamine concentration in both on the cultivars (Table 3). RLWC of the variety CoM 0265 by the application of putrescine and spermidine was 83.45% (0µM), 84.36% (100µM), 85.29% (500µM) and 80.00% (0µM), 83.55% (100µM), 84.25% (500µM) respectively in normal soil.

The RLWC of the variety CoM 0265 by the application of putrescine and spermidine was 82.16% (0µM), 83.83% (100µM), 84.88% (500µM) and 82.10% (0µM), 83.56% (100µM), 84.52% (500µM) respectively in sodic soil. The RLWC of the variety CoC 671 by the application of putrescine and spermidine was 78.67% (0µM), 80.22% (100µM), 81.66% (500µM) and 78.33% (0µM), 79.48% (100µM), 80.88% (500µM) respectively in normal soil.

The RLWC of the variety CoC 671 by the application of putrescine and spermidine was 73.45% (0µM), 76.12% (100µM), 77.89% (500µM) and 73.34% (0µM), 75.94% (100µM), 77.12% (500µM) respectively in sodic soil. The interaction effect was found to be significant with long-term water stress, RLWC decreased in lime seedling (Amri and Shahsavar, 2010).

**Table.1** Effect of polyamines on seedling height of sugarcane grown on normal and sodic soils

| Sr. No. | Name of the cultivar / Name of the polyamine | Seedling height (cm) | | | | | | Fold Increase (+) / Fold Deacrease (-) |
|---|---|---|---|---|---|---|---|---|
| | | Normal soil | | | Sodic soil | | | |
| | | Concentration of the polyamine (µM) | | | | | | |
| | | 0 | 100 | 500 | 0 | 100 | 500 | |
| **1.** | **CoM 265 (Salt tolerant cultivar)** | | | | | | | |
| **a.** | Putrescine | 11.2<br>(00) | 11.9<br>(+1.06) | 12.7<br>(+1.13) | 9.8<br>(-0.88) | 10.7<br>(-0.96) | 11.8<br>(+1.05) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.09) | (+1.20) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.90) | (-0.93) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 10.8<br>(00) | 11.2<br>(+1.04) | 11.6<br>(+1.07) | 9.6<br>(-0.89) | 10.4<br>(-0.96) | 11.0<br>(+1.02) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.08) | (+1.15) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.93) | (-0.95) | **Over respective Spermidine conc.** |
| **2.** | **CoC 671 (Salt susceptible cultivar)** | | | | | | | |
| **a.** | Putrescine | 7.2<br>(00) | 8.5<br>(+1.19) | 10.2<br>(+1.42) | 7.0<br>(-0.97) | 10.2<br>(+1.42) | 13.2<br>(+1.83) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.46) | (+1.89) | **Over the control of sodic soil** |
| | | - | - | - | - | (+1.2) | +1.30) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 7.3<br>(00) | 8.2<br>(+1.12) | 8.9<br>(+1.22) | 7.3<br>(-1) | 8.5<br>(+1.17) | 10.3<br>(+1.41) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.17) | (+1.41) | **Over the control of sodic soil** |
| | | - | - | - | - | (+1.04) | (+1.16) | **Over respective Spermidine conc.** |

| **Comparison** | S.Em. ± | CD at 5% | **Comparison** | S.Em. ± | CD at 5% |
|---|---|---|---|---|---|
| Variety (V) | 0.037 | 0.14 | T*L | 0.064 | 0.18 |
| Soil (S) | 0.037 | 0.14 | T*S | 0.052 | 0.15 |
| Type of polyamine (T) | 0.037 | 0.10 | V*S*T | 0.074 | 0.21 |
| Conc. of Polyamines (L) | 0.045 | 0.13 | V*T*L | 0.091 | 0.26 |
| V*S | 0.052 | 0.15 | S*T*L | 0.091 | 0.26 |
| V*T | 0.052 | 0.15 | V*S*L | 0.091 | 0.26 |
| | | | **V*S*T*L** | **0.125** | **0.38** |

**Table.2** Effect of polyamines on root length of seedling sugarcane grown on normal and sodic soils

| Sr. No. | Name of the cultivar/ Name of the polyamine | Root length of Seedling (cm) | | | | | | Fold Increase (+) / Fold Decrease (-) |
|---|---|---|---|---|---|---|---|---|
| | | Normal soil | | | Sodic soil | | | |
| | | Concentration of the polyamine (µM) | | | | | | |
| | | 0 | 100 | 500 | 0 | 100 | 500 | |
| **1.** | **CoM 265 (Salt tolerant cultivar)** | | | | | | | |
| **a.** | Putrescine | 6.2 (00) | 6.8 (+1.09) | 7.6 (+1.22) | 5.5 (-0.88) | 6.1 (-0.98) | 7.0 (+1.12) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.10) | (+1.27) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.93) | (-0.92) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 6.1 (00) | 6.5 (+1.06) | 6.9 (+1.13) | 5.7 (-0.93) | 6.3 (-1.03) | 6.6 (+1.08) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.10) | (+1.15) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.96) | (-0.95) | **Over respective Spermidine conc.** |
| **2.** | **CoC 671 (Salt susceptible cultivar)** | | | | | | | |
| **a.** | Putrescine | 6.0 (00) | 6.9 (+1.15) | 8.0 (+1.34) | 4.9 (-0.82) | 6.3 (+1.05) | 7.5 (+1.25) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.29) | (+1.53) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.91) | (-0.94) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 6.2 (00) | 6.6 (+1.07) | 7.5 (+1.20) | 5.0 (-0.81) | 6.1 (-0.98) | 7.1 (+1.15) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.22) | (+1.42) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.93) | (-0.95) | **Over respective Spermidine conc.** |
| | **Comparison** | S.Em. ± | CD at 5% | | **Comparison** | S.Em. ± | CD at 5% | |
| | Variety (V) | 0.045 | 0.13 | | T*L | 0.079 | 0.22 | |
| | Soil (S) | 0.045 | 0.13 | | T*S | 0.064 | 0.18 | |
| | Type of polyamine (T) | 0.045 | 0.13 | | V*S*T | 0.091 | 0.26 | |
| | Conc. of Polyamines (L) | 0.056 | 0.15 | | V*T*L | 0.112 | 0.31 | |
| | V*S | 0.064 | 0.18 | | S*T*L | 0.112 | 0.31 | |
| | V*T | 0.064 | 0.18 | | V*S*L | 0.112 | 0.42 | |
| | | | | | **V*S*T*L** | **0.158** | **0.45** | |

**Table.3** Effect of polyamines on relative leaf water content (RLWC) of sugarcane grown on normal and sodic soils

| Sr. No. | Name of the cultivar/ Name of the polyamine | Relative leaf water content (RLWC) (%) | | | | | | Fold Increase (+) / Fold Deacrease (-) |
|---|---|---|---|---|---|---|---|---|
| | | Normal soil | | | Sodic soil | | | |
| | | Concentration of the polyamine (µM) | | | | | | |
| | | 0 | 100 | 500 | 0 | 100 | 500 | |
| **1.** | **CoM 265 (Salt tolerant cultivar)** | | | | | | | |
| **a.** | Putrescine | 83.45 (00) | 84.36 (+1.01) | 85.29 (+1.02) | 82.16 (-0.99) | 83.83 (+1.01) | 84.88 (+1.02) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.02) | (+1.03) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.99) | (-0.100) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 83.00 (00) | 83.55 (+1.07) | 84.25 (+1.02) | 82.10 (-0.99) | 83.56 (+1.01) | 84.52 (+1.02) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.02) | (+1.03) | **Over the control of sodic soil** |
| | | - | - | - | - | (+1.00) | (+1.00) | **Over respective Spermidineconc** |
| **2.** | **CoC 671 (Salt susceptible cultivar)** | | | | | | | |
| **a.** | Putrescine | 78.67 (00) | 80.22 (+1.02) | 81.66 (+1.04) | 73.45 (-0.93) | 76.12 (-0.97) | 77.89 (-0.99) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.04) | (+1.06) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.95) | (-0.95) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 78.33 (00) | 79.48 (+1.02) | 80.88 (+1.03) | 73.34 (-0.94) | 75.94 (-0.97) | 77.12 (-0.99) | **Over the control of normal soil** |
| | | - | - | - | (00) | (+1.04) | (+1.05) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.96) | (-0.95) | **Over respective Spermidineconc** |

| **Comparison** | S.Em. ± | CD at 5% | **Comparison** | S.Em. ± | CD at 5% |
|---|---|---|---|---|---|
| Variety (V) | 0.004 | 0.012 | T*L | 0.007 | 0.021 |
| Soil (S) | 0.004 | 0.012 | T*S | 0.006 | 0.017 |
| Type of polyamine (T) | 0.004 | 0.012 | V*S*T | 0.008 | 0.024 |
| Conc. of Polyamines (L) | 0.005 | 0.015 | V*T*L | 0.010 | 0.030 |
| V*S | 0.006 | 0.017 | S*T*L | 0.010 | 0.030 |
| V*T | 0.006 | 0.017 | V*S*L | 0.010 | 0.030 |
| | | | **V*S*T*L** | **0.015** | **0.043** |

**Table.4** Effect of polyamines on membrane injury index in sugarcane leaves grown on normal and sodic soils

| Sr. No. | Name of the cultivar/ Name of the polyamine | Membrane injury index (%) | | | | | | Fold Increase (+) / Fold Decrease (-) |
|---|---|---|---|---|---|---|---|---|
| | | Normal soil | | | Sodic soil | | | |
| | | Concentration of the polyamine (µM) | | | | | | |
| | | **0** | **100** | **500** | **0** | **100** | **500** | |
| **1.** | **CoM 265 (Salt tolerant cultivar)** | | | | | | | |
| **a.** | Putrescine | 19.12 (00) | 19.00 (-0.99) | 18.87 (-0.98) | 19.27 (+1.00) | 19.12 (1) | 19.00 (-0.99) | **Over the control of normal soil** |
| | | - | - | - | (00) | (-0.99) | (-0.99) | **Over the control of sodic soil** |
| | | - | - | - | - | (+1.00) | (+1.00) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 19.25 (00) | 19.18 (-0.99) | 18.90 (-0.98) | 19.38 (+1.00) | 19.13 (-0.99) | 18.88 (-0.98) | **Over the control of normal soil** |
| | | - | - | - | (00) | (-0.98) | (-0.97) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.99) | (-0.99) | **Over respective Spermidineconc** |
| **2.** | **CoC 671 (Salt susceptible cultivar)** | | | | | | | |
| **a.** | Putrescine | 16.45 (00) | 16.38 (-0.100) | 16.30 (-0.99) | 16.62 (+1.01) | 16.39 (-0.99) | 16.20 (-0.98) | **Over the control of normal soil** |
| | | - | - | - | (00) | (-0.98) | (-0.97) | **Over the control of sodic soil** |
| | | - | - | - | - | (+1.00) | (-0.99) | **Over respective Putrescine conc.** |
| **b.** | Spermidine | 16.50 (00) | 16.40 (-0.99) | 16.32 (-0.98) | 16.65 (+1.00) | 16.38 (-0.99) | 16.30 (-0.98) | **Over the control of normal soil** |
| | | - | - | - | (00) | (-0.98) | (-0.97) | **Over the control of sodic soil** |
| | | - | - | - | - | (-0.99) | (-0.99) | **Over respective Spermidine conc** |
| | **Comparison** | S.Em. ± | CD at 5% | | **Comparison** | S.Em. ± | CD at 5% | |
| | Variety (V) | 0.42 | 1.20 | | T*L | 0.73 | 2.07 | |
| | Soil (S) | 0.42 | NS | | T*S | 0.59 | 1.69 | |
| | Type of polyamine (T) | 0.42 | NS | | V*S*T | 0.84 | 2.40 | |
| | Conc. of Polyamines (L) | 0.51 | 1.47 | | V*T*L | 1.03 | 2.94 | |
| | V*S | 0.59 | 1.69 | | S*T*L | 1.03 | 2.94 | |
| | V*T | 0.59 | 1.69 | | V*S*L | 1.03 | 2.94 | |
| | | | | | **V*S*T*L** | **1.46** | **4.15** | |

Application of polyamine spermidine the amount of RLWC significantly increased than control in lime seedlings. It was revealed that polyamine spermidine increases rate RLWC and can tolerate much stress. Water deficit greatly lowered RWC of cucumber roots, by as much as 60–65 % at the end of the 10-h stress period (Kubis *et al.*, 2014). However, in stressed plants treated with PAs, the dynamics of water content decrease was similar to that observed for untreated plants. There were no differences in RWC between PA-treated and untreated control plants.

## Membrane injury index

The sugarcane varieties *viz*., CoM 0265 salt tolerant and CoC 671 salt susceptible when grown in sodic soil recorded higher MII than grown in normal soil (Table 4). Application of polyamine resulted in amelioration in MII in sugarcane varieties caused by sodicity. The membrane injury index of the variety CoM 0265 by the application of putrescine and spermidine was 19.12% (0µM), 19.00% (100µM), 18.87% (500µM) and 19.25% (0µM), 19.18% (100µM), 18.90% (500µM) in normal soil. The membrane injury index of the variety CoM 0265 by application of putrescine and spermidine was 19.27% (0µM), 19.12% (100µM), 19.00% (500µM) and 19.38% (0µM), 19.13% (100µM), 18.88% (500µM) in sodic soil.

The membrane injury index of the variety CoC 671 by the application of putrescine and spermidine was 16.45% (0µM),16.38% (100µM), 16.30% (500µM) and 16.50% (0µM), 16.40% (100µM), 16.32% (500µM) in normal soil. The membrane injury index of the variety CoC 671 at concentration of putrescine and spermidine was 16.62% (0µM), 16.39% (100µM), 16.20% (500µM) and 16.65% (0µM), 16.38% (100µM), 16.30% (500µM) in sodic soil. Patade *et al.*, (2011) reported that the electrolytic conductivity of the leaf sap was significantly more in salt and PEG stressed plants than the control in sugarcane plant. In the present investigation MII was increased in the plants grown in sodic soil. Injury to plants caused by various stresses is associated with oxidative damage at cellular level such as cell membrane damage. Kubis *et al.,* (2014) reported that plant treated with PAs showed significant reduction of stress-induced electrolyte leakage, depending upon water stress duration. Similar trend was observed in the present investigation

The root length of seedling and seedling height were reduced in both the sugarcane varieties when grown in sodic soil, however it was recovered due to application of putrescine and spermidine. The RLWC reduction was higher in sugarcane variety CoC 671 grown in sodic soil as compared to CoM 0265.

Application of different concentration putrescine and spermidine increased RLWC both in CoM 0265 and CoC 671. The membrane injury index was more in the leaves of sugarcane cultivars when grown in sodic than the normal soil. The effect of sodicity on membrane injury index was found to be ameliorated by application of putrescine and spermidine.

In conclusion application of polyamines at 500 µM is found to ameliorate the adverse effect of soil sodicity and sustain the sugarcane growth.

## References

Agarwal, S. and Pandey, V. 2004. Antioxidant enzyme responses to NaCl stress in *Cassia angustifolia.* Biol. Plant. 48:555-560.

Alcazar, R., Altabella, T., Marco, F., Bortolotti, C., Reymond, M., Knocz, C., Carrasco, P. and Tiburcio, A.F. 2010. Polyamines molecules with regulatory functions in plant abiotic stress tolerance. Planta. 231: 1237–49.

Alet, A. I., Sánchez, D. H., Cuevas, J.C., Marina. M., Carrasco, P. Altabella, T. Tiburcio, A. F. and Ruiz, O. A. 2012. New insights into the role of spermine in Arabidopsis thaliana under long-term salt stress. Plant Sci. 182: 94–100.

Amris, Mohammad. Mirzaei., Majid, Moradi. And Kavooszare. 2011. The effect of spermidine and putrescine polyamines on growth of pomegranate (*Punica granatum* L. cv 'Rabbab') in salinity circumstance. Inter. J. Plant Physiol. Biochem. 3(3): 43-49.

Castillo, E. G., Tuong, T. P., Ismail, A. M. and Inubushi, K. 2007. Response to salinity in rice: comparative effects of osmotic and ionic stresses. Plant Prod. Sci. 10: 159-170.

Chartres, C.J. 1993. Sodic soils: An introduction to their formation and distribution in Australia. Australian Journal of Soil Research 31:751–760.

Chattopadhayay, M. K., Tiwari, B. S., Chattopadhyay, G., Bose, A., Sengupta, D. N. and Ghosh, B. 2002. Protective role of exogenous polyamines on salinity-stressed rice *Oryza sativa* plants. Physiol. Plant 116: 192-199.

Duan, J., Li, J., Guo, S. and Kang, Y. 2008. Exogenous spermidine affects polyamine metabolism in salinity-stressed *Cucumis sativus* roots and enhances short-term salinity tolerance. J. Plant Physiol. 165: 1620-1635.

Hussain, S. S., Ali, M., Ahmad, M. and Siddique, K. H. M. 2011. Polyamines: natural and engineered abiotic and biotic stress tolerance in plants. Biotechnol. 29: 300–311.

Indiastat 2015. https://www. Indiastat.Com.

Kubis. 2014. Polyamines induce adaptive responses in water deficit stressed cucumber roots. J. Plant Res. 127: 151-158.

Lutts, S., Almansouri, M. and Kinet, J.M. 2004. Salinity and water stress have contrasting effects on the relationship between growth and cell viability during and after stress exposure in durum wheat callus. Plant Sci. 167(1): 9-18.

Meiri, A. and Poljakoff-Mayber, A. 1970. Effect of various salinity regimes on growth, leaf expansion and transpiration rate of Bean plants. Soil Sci. 109: 26- 34.

Misra, N. and Dwivedi U. N. 2004.Genotypic difference in salinity tolerance of green gram cultivars. Plant Sci. 166: 1135-1142.

Molaei, P., Ali, E.A.N. and Teymur, K.B. 2012.Water relation, solute accumulation and cell membrane injury in sesame cultivars *Sesamum indicum* subjected to water stress. Annu. Biol. Res. 3(4): 1833-1838

Munns, R. and Termaat, A. 1986.Whole-plant response to salinity. Aust. J. Plant Physiol. 13:143-162.

Munns, R. and Tester, M. 2008. Mechanisms of salinity tolerance. Annu. Rev. Plant Biol. 59:651-81.

Pagariya, M.C., Devarumatha, R.M. and Kawara, P.G. 2011. Biochemical characterization and identification of differentially expressed candidate genes in salt stressed sugarcane. Plant Sci. 184: 1-13.

Richards, L.A. 1954. Diagnosis and improvements of saline and alkali soils (U.S. Department of Agriculture Handbook 60). Washington, D.C.: U.S. Salinity Laboratory DA.

Sumner, M.E., Miller, W.P., Kookana, R.S. and Hazelton, P. 1998. Sodicity, dispersion, and environmental quality. In Sodic soils - Distribution, properties, management, and environmental Consequences, ed. M. E. Sumner and R. Naidu.

Wahid, A. and Ghazanfar, A. 2006.Possible involvement of some secondary metabolites in salt tolerance of sugarcane. J. Plant Physiol. 163: 723-730.

Zhang, R. H., Li, J., Guo, S. R. and Tezuka, T. 2009. Effects of exogenous putrescine on gas exchange characteristics and chlorophyll fluorescence of NaCl-stressed cucumber seedlings. Photosynth Res 100: 155–162.

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