RESEARCH ARTICLE

# GENOTYPIC RESPONSE OF RECENTLY EVOLVED SUGARCANE "CO" CLONES UNDER DIFFERENT LEVELS OF SALINE IRRIGATION WATER

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**Abstract**

An experiment was conducted with 24 sugarcane elite "Co" genotypes under factorial RBD to identify the impact of three salinity level of irrigation water (iw) viz., $S^1$ ($4EC_{iw}$), $S^2$ ($8EC_{iw}$) and $S^3$ ($12EC_{iw}$) along with control $S^0$ (Normal $EC_{iw}$), on cane yield and juice quality traits and to observe the genotypic response against salinity. All the three salinity levels had the negative impact on the expression of all the traits studied, however the magnitude of reduction was highest at $S^3$ level for CCS yield (66.4%), cane yield (63.9%), NMC (41.9%), SCW (37.7%), stalk height (34.5%), tiller population (29.6%) and juice extraction% (27.6%) in comparison to control ($S^0$), whereas, juice purity%, Brix%, sucrose%, CCS% and cane diameter were the least affected traits. At $S^3$ level of salinity genotypes Co 14034 (48.98 t/ha), Co 0238 (47.83 t/ha), Co 15023 (44.76 t/ha), Co 14036 (43.7 t/ha) and Co 15027 (43.4 t/ha) were the highest cane yielder. The least reduction for cane yield at $S^3$ compared to $S^0$ was observed in genotypes Co 14034 (37.0%), Co 13035 (41.4%), Co 98014 (49.7%), CoS 767 (50.3%), Co 1148 (53.7%), Co 1148 (53.7%) and Co 0238 (58.1%), whereas highest reduction was observed in Co 0237 (81.9%), Co 13033 (79.5%), Co 12026 (78.5%), Co 06034 (79.7%), Co 05009 (72.6%) and Co 13034 (72.7%). Based on salinity tolerance index, genotypes Co 13035, Co 14034, CoS 767, Co 15023, Co 98014, Co 15027, Co 1148, Co 0238, Co 14036, Co 0118, Co 13036, Co 12027 and Co 15026 were found tolerant /moderately tolerant, whereas Co 12026, Co 13033, Co 06034 and Co 0237 were sensitive. The tolerant/ moderately tolerant varieties viz., Co 98014, Co 0238 and Co 0118 can be grown in salinity affected area of NWZ. All the tolerant and moderately tolerant genotypes can also be utilized in breeding programme towards development of sugarcane varieties with salinity tolerance. Half of the salinity tolerant/moderately tolerant genotypes are derived using Co 8347 and Co 0241 as either of the parents indicates their role in imparting salinity tolerance.

**Key words:** Sugarcane, salinity tolerance, salinity tolerance index, salt tolerant varieties

## Introduction

Sugarcane is an important industrial crop, fulfils nearly 80% sweetener requirement of the world. It is cultivated under varied climatic conditions of tropical and sub-tropical environments of the world. The wider spread adoption of better sugarcane varieties viz., Co 0238, Co 86032, CoM 0265, Co 0118 etc., and management practices in India have changed the notion of the crop from "Lazy men's crop" to "Active men's crop". India has witnessed the record high production of sugarcane (376.9 m ton; Anon. 2018) and sugar (32.25 m tons; ISMA, 2018) during the crop year 2017-18. The gain in sugarcane productivity around the world is the outcome of combined effect of crop improvement and management practices.. Various environmental (biotic and abiotic) and agronomic (crop geometry, planting time, crop duration, rotation, water, weeds, diseases, pests and nutrients management practices, crop lodging etc) factors limits the full expression of crop yield potential.

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Salinity is one of the important abiotic factors limiting the cane yield and juice quality. Irrigation-induced salinity and/or sodicity in sugarcane have been reported in Australia, Egypt, Iraq, United States, India, Pakistan, Swaziland, South Africa and Zimbabwe (Hussein, 1998; Haynes and Hamilton, 1999). In the more arid, irrigated areas of the world, soil salinity and sodicity are considered to greatly limit sugarcane yield (Rozeff, 1998; Nelson and Ham, 2000). Increasing soil salinity and/or sodicity is the most significant soil chemical processes causing soil degradation under irrigated sugarcane (van Antwerpen and Meyer 1996). In India, as 15-20 per cent of sugarcane area is affected by high pH and high EC conditions, which results in adverse effects of excess salts on sugarcane yield, sugar recovery and juice quality (Anon. 1998). Although several lakh hectares of saline soil had been reclaimed in India but the longer duration of sugarcane crop requires several irrigations, in areas where saline underground water is the main source of irrigation water, the crop yield reduces significantly.

Sugarcane is considered moderately sensitive against salinity and sensitive against sodicity (Workman et al. 1986; Nelson and Ham, 2000). Salinity usually causes water stress through osmotic effects while sodicity results in an increased pH, nutrient imbalances and clay dispersion which results in a breakdown in soil structure, poor penetration of water, air and roots, low readily-available water holding capacity and difficulties in timely and effective tillage (Gupta and Abrol, 1990; Nelson and Ham, 2000). The difference in varietal response against different levels of salinity (Simoes et al. 2016) indicates that screening sugarcane genotypes under salinity is very important towards identification of salinity tolerant sugarcane varieties for immediate use and as donor parent for the development of future sugarcane varieties. The present study was initiated to screen the recently evolved "Co" sugarcane genotypes at ICAR-Sugarcane Breeding Institute, Regional Centre, Karnal against various levels of salinity.

## Material and Methods

The material consisting of 36 genotypes was preliminary screened under endemic salinity area at Nain farm (Panipat) of ICAR-Central Soil Salinity Research Institute, Karnal during crop season 2015-16 under RBD layout with four replications. During crop season 2016-17, out of 36, twenty four genotypes developed Co canes and important sugarcane varieties were chosen for further screening under pits at different levels of salt concentrations at ICAR-SBI, RC, Karnal. The experiment was planted in round pits of size 60 cm x 45 cm using factorial RBD with three replications. The salinity was imposed using three levels of saline irrigation water 4 $EC_{iw}$ ($S^1$), 8 $EC_{iw}$ ($S^2$) and 12 $EC_{iw}$ ($S^3$) along with control (normal water). The saline water of 12 EC brought from Nain farm of ICAR-CSSRI, Karnal was used in making desired EC levels irrigation water by diluting normal water. The pH and EC of normal water used for irrigation was 7.7 and 0.01 $dSm^{-1}$ respectively. A total of 12 two budded setts of each genotypes were planted in each pit during second fortnight of March 2016. The buds were allowed to germinate by providing normal irrigation water till one month at an interval of 7-10 days. After 30 days of planting the normal water ($S^0$), saline water of 4 EC ($S^1$), 8EC ($S^2$) and 12 EC ($S^3$) was used for irrigation at 10 days interval till the onset of monsoon. During monsoon season the

**Table 1. Soil salinity status (ECe) $dSm^{-1}$ maintained before and after imposition of the salinity stress**

| Treatments | Before stress | After stress |
|---|---|---|
| $S^0$ ($normal_{iw}$) | 1.56 | 1.61 |
| $S^1$ ($4EC_{iw}$) | 1.55 | 3.48 |
| $S^2$ ($8EC_{iw}$) | 1.62 | 5.20 |
| $S^3$ ($12EC_{iw}$) | 1.59 | 7.84 |

crop was irrigated as and when required with the different salinity levels of irrigation water. The level of soil salinity developed due to application of saline irrigation water is presented in table 1. Except salinity treatments normal recommended package and practices were followed to grow the crop. Observations on various metric traits viz., tiller population at 120 days after planting (DAP), number of millable cane (NMC) at 240 DAP, stalk height (cm), stalk diameter (cm), single stalk weight (SSW), juice extraction (%) were recorded at 300 DAP. Random samples of five canes were taken for juice analysis and various parameters viz., cane yield (t/ha), CCS%, CCS (t/ha), juice Brix (%), juice sucrose (%), juice purity (%) were estimated as per Chen and Chou (1993). The data were analysed using online statistical tool OPSTAT.

## Results and Discussion

The analysis of variance (Table 2) revealed the significant difference in the expression of all the traits studied at different levels of salinity. The genotypes also differ from each other in the expression of the studied traits. The interaction effect between salinity levels and genotypes was also significant for CCS yield, cane yield and contributing traits viz.,  SCW, NMC, tillers/ha, extraction%, stalk diameter and stalk height. But the salinity x genotypes interactions for juice quality parameters *viz.*, brix%, pol%, purity% and CCS% were insignificant, thereby indicating that juice quality of different sugarcane genotypes was not influenced by different levels of salinity. Therefore, selection for juice quality traits would be more effective under varied salinity levels in comparison with cane yield and its component traits.

### Impact of salinity in the expression of the cane yield and juice quality traits

The increased level of salinity had negative impact on the expression of different cane yield and juice quality traits *viz*., CCS yield, cane yield, NMC, SCW, stalk height, stalk diameter, tillers, juice extraction%, CCS%, sucrose%, Brix% and purity % (Table 3). The reduction in mean values was significant from $S^0$ to $S^1$ to $S^2$ to $S^3$ (the highest reduction being in $S^3$) for all the traits studied except juice quality traits. The rate of reduction in mean performance increases from $S^1$ to $S^2$ to $S^3$. Cane and CCS yields showed the highest reduction at $S^3$ (63.86 % and 66.32%, respectively) followed by $S^2$ (50.85% and 52.72%, respectively) and $S^1$ (19.54% and 21.44%, respectively). The detrimental effect of saline water irrigation on sugarcane yield was also reported by Lira et al. (2018).

**Table 2. ANOVA for various traits and significance of source of variance at 5% level of probability**

| Source of Variance | df | Mean Sum of Square | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CCS (t ha$^{-1}$) | Cane yield (t ha$^{-1}$) | SCW (kg) | NMC ('000/ ha) | Tiller/ha ('000/ha) | Extrac--tion% | Stalk dia (cm) | Stalk height | Brix% | Pol% | Purity % | CCS% |
| Salinity levels | 3 | 574.06* | 37115.99* | 2.40* | 14498.6* | 13819.2* | 2923.4* | 1.31* | 7349.21* | 12.64* | 15.29* | 22.87* | 8.78* |
| Genotypes | 23 | 47.215* | 3000.07* | 0.43* | 994.18* | 1399.31* | 215.28* | 0.83* | 3952.4* | 13.94* | 25.02* | 104.72* | 16.43* |
| Salinity x genotypes | 69 | 3.28* | 198.39* | 0.034* | 114.64* | 165.6* | 41.38* | 0.04* | 753.99* | 0.36 | 0.59 | 5.46 | 0.419 |
| Error | 190 | 0.489 | 23.03 | 0.003 | 16.39 | 33.88 | 12.61 | 0.018 | 122.35 | 0.53 | 0.64 | 5.28 | 0.417 |

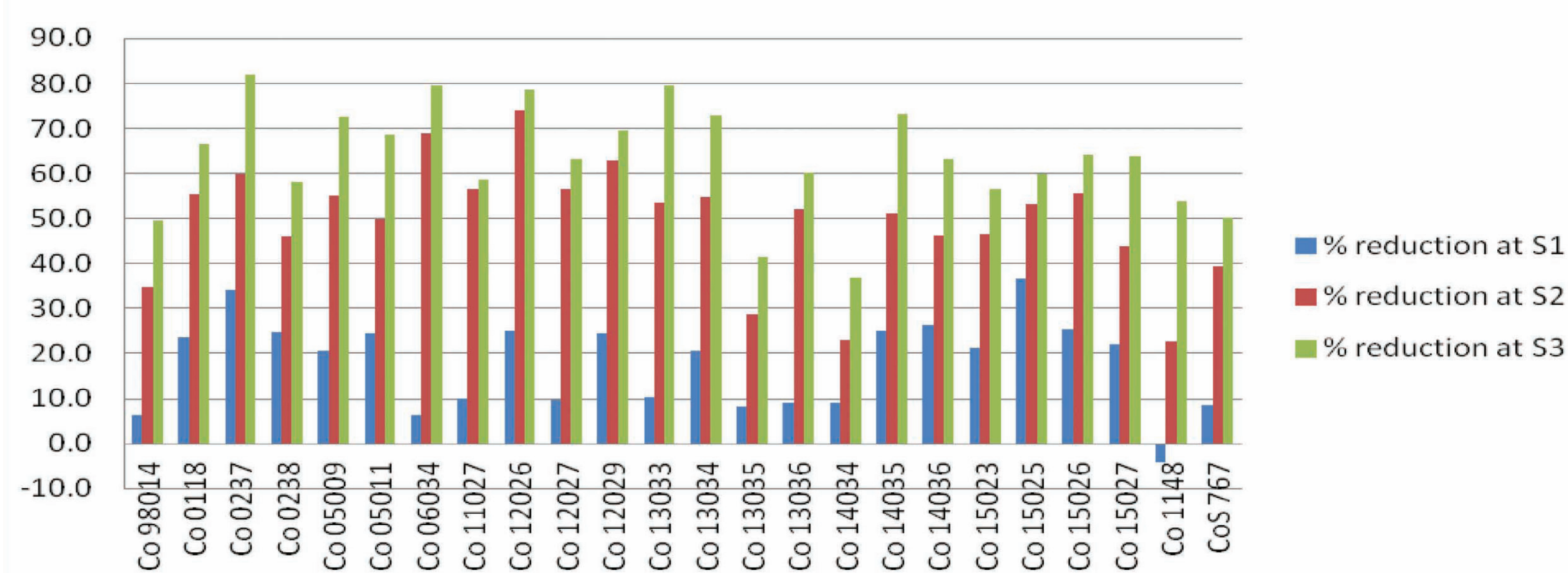


**Fig. 1. Genotypic response in percent reduction of cane yield (t ha$^{-1}$) at difference levels of salinity over control**

**Table 3. Mean performance of different traits at different salinity levels**

| Traits | Mean performance of different traits | | | | | |
|---|---|---|---|---|---|---|
| | $S^0$ | $S^1$ | $S^2$ | $S^3$ | Mean | CD 5% |
| CCS (t $ha^{-1}$) | 9.6a | 7.5b | 4.5c | 3.2d | 6.2 | 0.24 |
| Cane yield (t $ha^{-1}$) | 79.3a | 63.8b | 39.0c | 28.7d | 52.7 | 1.57 |
| NMC (‘000/ha) | 72.5a | 65.4b | 48.6c | 42.1d | 57.1 | 1.37 |
| SCW (kg) | 1.1a | 1.0b | 0.8c | 0.68d | 0.89 | 0.02 |
| Stalk height (cm) | 207.2a | 184.1b | 152.4c | 135.8d | 169.9 | 3.61 |
| Stalk Diameter (cm) | 2.6a | 2.5b | 2.4c | 2.3d | 2.4 | 0.04 |
| Tillers (‘000/ha) | 117.0a | 102.0b | 90.2c | 82.3d | 97.9 | 1.90 |
| Juice extraction% | 52.0a | 45.2b | 40.0c | 37.7d | 43.7 | 1.16 |
| CCS% | 12.1a | 11.8b | 11.6b | 11.22d | 11.7 | 0.22 |
| Sucrose% | 17.4a | 17.0b | 16.8b | 16.29d | 16.9d | 0.25 |
| Brix% | 19.6a | 19.2b | 19.0b | 18.59d | 19.1 | 0.24 |
| Purity% | 88.6a | 88.4a | 88.0ab | 87.35b | 88.1 | 0.74 |

*Different letters indicate significant differences at 5% level of significance

Although the highest impact of salinity stress was reflected on dependent traits like cane yield and sugar yield but there was significant reduction in several independent yield contributing and juice quality traits as well. There was 13.1%, 12.8%, 11.2%, 10.8% and 9.8% reduction in juice extraction%, tillers (‘000/ha), stalk height, single stalk weight (SSW) and Number of millable canes (NMC ‘000/ha) respectively at $S^1$ salinity level compare to control ($S^0$). At treatment $S^2$, there was 33.01%, 26.63%, 26.47% , 23.19% and 22.9% reduction over control ($S^0$) for NMC, SSW, Stalk height, juice extraction% and tillers population (‘000/ha) respectively. At $S^3$ level of salinity, the highest reduction was observed for NMC (41.94%) followed by SSW (37.73%), stalk height (34.45%) tiller population (29.6%) and juice extraction (27.58%). Saxena et al. (2010) also reported 8.8-56.6% reduction in shoot height in sugarcane under salinity. Similarly Lira et al. (2018) also concluded in their finding that irrigation water salinity negatively influenced the variables of growth and yield in sugarcane.

The juice quality traits differ significantly at $S^1$ and $S^3$ level of salinity over $S^0$. Lingle et al. (2000) also reported reduction in brix% and sucrose% with the increase in salt concentration. The performance of juice quality traits viz., CCS% (12.06), pol% (17.39), brix% (19.59) and purity% (88.63) was highest at normal $EC_{iw}$. There was significant reduction in juice quality parameters with the increase of salinity levels, i.e. $S^0$ to $S^1$, $S^0$ to $S^3$ and $S^2$ to $S^3$.

### Genotypic response for CCS yield (t $ha^{-1}$) and cane yield (t $ha^{-1}$) at different level of salinity

Eight of the genotypes produced significantly higher CCS yield (Table 4) over treatment mean at control ($S^0$). The top performing promising genotypes were Co 15027 (14.48), Co 0238 (14.36), Co 15023 (14.34) and Co 12029 (14.30). At the $S^1$ salinity level nine genotypes could produce significantly higher sugar yield over treatment mean (7.51 t $ha^{-1}$). Co 15023

**Table 4. Expression of different genotypes for sugar and stalk yield at different salinity levels**

| Genotypes | CCS t ha$^{-1}$ | | | | | Cane yield t ha$^{-1}$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $S^0$ | $S^1$ | $S^2$ | $S^3$ | Mean | $S^0$ | $S^1$ | $S^2$ | $S^3$ | Mean |
| Co 98014 | 8.61a* | 7.86a | 5.31c | 3.97d | **6.43** | 70.38a | 65.87b | 45.97c | 35.38d | **54.40** |
| Co 0118 | 12.90a | 10.14b | 5.86c | 4.15d | **8.26** | 104.62a | 80.00b | 46.87c | 34.94d | **66.61** |
| Co 0237 | 7.18a | 4.76b | 2.90c | 1.07d | **3.98** | 52.18a | 34.40b | 20.98c | 9.44d | **29.25** |
| Co 0238 | 14.36a | 10.45b | 7.38c | 5.68d | **9.47** | 114.17a | 85.73b | 61.78c | 47.83d | **77.38** |
| Co 05009 | 7.08a | 5.65b | 3.10c | 1.74d | **4.39** | 63.00a | 49.94b | 28.41c | 17.28d | 39.66 |
| Co 05011 | 11.93a | 8.54b | 5.48c | 3.37d | **7.33** | 102.76a | 77.51b | 51.40c | 32.10d | **65.94** |
| Co 06034 | 8.09a | 7.55a | 2.53c | 1.62c | **4.95** | 63.44a | 59.41a | 19.80c | 12.91c | **38.89** |
| Co 11027 | 5.80a | 5.19a | 2.51c | 2.43c | **3.98** | 58.39a | 52.48a | 25.31c | 24.21c | **40.10** |
| Co 12026 | 8.54a | 5.98b | 2.02c | 1.56c | **4.53** | 66.85a | 50.13b | 17.40c | 14.36c | **37.19** |
| Co 12027 | 5.83a | 5.18a | 2.41c | 2.01c | **3.86** | 42.16a | 38.03a | 18.35c | 15.50c | **28.51** |
| Co 12029 | 14.30a | 10.70b | 5.18c | 4.19c | **8.59** | 116.64a | 87.93b | 43.27c | 35.37d | **70.80** |
| Co 13033 | 7.51a | 6.75a | 3.32c | 1.43d | **4.76** | 62.07a | 55.59a | 28.86c | 12.74d | **39.82** |
| Co 13034 | 9.80a | 7.77b | 4.29c | 2.48d | **6.08** | 79.46a | 63.00b | 35.97c | 21.66d | **50.02** |
| Co 13035 | 9.62a | 8.68a | 6.66c | 5.33d | **7.57** | 73.51a | 67.43a | 52.44c | 43.11d | **59.12** |
| Co 13036 | 8.11a | 6.84b | 3.75c | 2.94c | **5.41** | 72.92a | 66.36a | 35.06c | 29.13c | **50.87** |
| Co 14034 | 9.62a | 8.80a | 7.30c | 6.06d | **7.95** | 77.73a | 70.68a | 59.75c | 48.98d | **64.28** |
| Co 14035 | 7.30a | 5.16b | 3.38c | 1.84d | **4.42** | 61.15a | 45.82b | 29.91c | 16.43d | **38.32** |
| Co 14036 | 12.33a | 8.12b | 5.76c | 3.85d | **7.52** | 118.50a | 87.17b | 63.68c | 43.70d | **78.26** |
| Co 15023 | 14.34a | 11.39b | 7.68c | 6.21d | **9.90** | 103.20a | 81.43b | 55.24c | 44.76d | **71.16** |
| Co 15025 | 10.43a | 5.80b | 4.16c | 3.55c | **5.99** | 79.43a | 50.33b | 37.06c | 31.78c | **49.65** |
| Co 15026 | 8.43a | 5.99b | 3.43c | 2.70c | **5.14** | 82.05a | 61.13b | 36.40c | 29.56c | **52.29** |
| Co 15027 | 14.86a | 11.39b | 8.26c | 5.11d | **9.91** | 119.90a | 93.40b | 67.23c | 43.40d | **80.98** |
| Co 1148 | 7.02a | 7.10a | 5.27b | 3.21c | **5.65** | 66.58a | 69.47a | 51.40b | 30.81c | **54.57** |
| CoS 767 | 5.47a | 5.10a | 3.39b | 2.70b | **4.17** | 51.69a | 47.32a | 31.40b | 25.68b | **39.02** |
| Mean | 9.56a | 7.51b | 4.52c | 3.22d | **6.20** | 79.31a | 63.81b | 38.99c | 28.66d | 52.69 |
| | | | | | CD | | | | | |
| | Salinity levels | | | | 0.23 | | | | | 1.58 |
| | Genotypes | | | | 1.12 | | | | | 7.68 |
| | Salinity x Genotypes | | | | 1.13 | | | | | 7.74 |

*Different letters indicate significant differences at 5% level of significance where a>b>c>d

(11.39 t ha$^{-1}$) and Co 15027 (11.39) were the top performer clones followed by Co 12029 (10.7 t ha$^{-1}$) and Co 0238 (10.45t ha$^{-1}$). Ten of the genotypes produced significantly higher sugar yield over treatment mean at 8 $EC_{iw}$ (4.52 t/ha) among them Co 15027 (8.26 t ha$^{-1}$), Co 15023 (7.68 t ha$^{-1}$), Co 0238 (7.38 t ha$^{-1}$) and Co 14034 (7.3 t ha$^{-1}$) were the top performer. At 12 $EC_{iw}$ salinity level, the treatment mean was 3.22 t/ha, nearly three times less than the normal $EC_{iw}$. Nine of the genotypes produced significantly higher sugar yield over the treatment mean among them Co 15023 (6.21 t ha$^{-1}$) followed by Co 14034 (6.06 t ha$^{-1}$) and Co 0238 (5.68 t ha$^{-1}$) were the top performer.

In control ($S^0$) seven genotypes Co 15027 (119.9 t $ha^{-1}$), Co 14034 (118.5 t/ha), Co 12029 (116.44 t $ha^{-1}$), Co 0238 (114.17 t $ha^{-1}$), Co 0118 (104.62 t $ha^{-1}$), Co 15023 (103.3 t/ha) and Co 05011 (102.76 t/ha) produced significantly higher cane yield (table 4) over treatment mean (79.31 t $ha^{-1}$). At $S^1$ five of the genotypes viz., Co 15027 (93.4 t $ha^{-1}$), Co 12029 (87.93 t $ha^{-1}$), Co 0238 (85.73 t $ha^{-1}$), Co 15023 (81.43 t $ha^{-1}$) and Co 0118 (80.0 t $ha^{-1}$) produced significantly higher cane yield over the treatment mean. Ten of the genotypes produced higher cane yield over treatment mean at $S^2$ level of salinity, among them Co 15027 (67.23 t $ha^{-1}$), Co 14036 (63.68 t $ha^{-1}$), Co 0238 (61.78 t $ha^{-1}$) and Co 14034 (59.75 t $ha^{-1}$) were the best performer. In treatment $S^3$ nine of the genotypes produced significantly higher cane yield over treatment average. Co 14034 (48.98 t/ha) followed by Co 0238 (47.83 t $ha^{-1}$), Co 15023 (43.7 t $ha^{-1}$) and Co 15027 (43.4 t $ha^{-1}$) were the promising entries.

In general, genotypes showed significant reduction in cane and CCS yields with increasing levels of salinity with following exceptions (Table 4). Co 06034, Co 11027, Co 12027 and CoS 767showed similar cane and CCS yields at $S^0$ and $S^1$, and $S^2$ and $S^3$ levels whereas Co 12026, Co 13036, Co 15025 and Co 15026 showed similar cane and CCS yields at $S^2$ and $S^3$ levels of salinity. Co 13033, Co 13035, Co 14034 and Co 1148 showed similar cane and CCS yields at $S^0$ and $S^1$ levels. Co 98014 showed similar CCS yield at $S^0$ and S1 levels whereas Co 12029 showed similar CCS yield at $S^2$ and $S^3$ levels of salinity.

The highest reduction (Fig. 1) was observed in genotypes Co 15025 (36.6%) followed by Co 0237 (34.1%) and Co 14036 (26.4%) indicating that these genotypes are highly sensitive to salinity as their yield reduced drastically at first level (S1) of salinity itself. Genotypes Co 1148 (-4.3%), Co 06034 (6.4%), Co 13035 (8.3%), CoS 767 (8.5%), Co 14034 (9.1%), Co 12027 (9.8%) and Co 13033 (10.4%) showed lesser reduction in cane yield indicating that they are tolerant at $S^1$ salinity stress. At $S^2$ the average reduction in cane yield was 50.8% indicating that sugarcane is highly sensitive at this level of stress. Among the genotypes the reduction was highest in Co 12026 (74.0%) followed by Co 06034 (68.8%), Co 12029 (62.9%) and Co 0237 (59.8%) indicating their high sensitivity at this level of salinity stress. Genotypes Co 1148 (22.8%), Co 14034 (23.1%), Co 13035 (28.7%) and Co 98014 (34.7%) depicted least reduction in cane yield at $S^2$ over control ($S^1$) indicating that though they exhibited significant reduction in cane yield but are comparatively tolerant than the other studied genotypes. There was drastic reduction of cane yield (63.9%) at $S^3$ as compare to $S^0$. Santana et al. (2007) also observed that sugarcane yield can be reduced by 50% in soils with electrical conductivity of 10.4 dS $m^{-1}$. Genotypes Co 0237 (81.9%), Co 13033 (79.5%), Co 12026 (78.5%), Co 06034 (79.7%), Co 05009 (72.6%) and Co 13034 (72.7%), depicted >70% reduction in cane yield indicating their higher sensitivity to elevated level (12 $EC_{iw}$) of salinity treatment. The least reduction in cane yield at $S^3$ compare to $S^0$ was observed in genotypes Co 14034 (37.0%), Co 13035 (41.4%), Co 98014 (49.7%), CoS 767 (50.3%), Co 1148 (53.7%), Co 1148 (53.7%) and Co 0238 (58.1%).

## Salinity tolerance index (STI)

To define the genotypes into tolerance or sensitive categories various salinity tolerance indices are under use *viz.,* Yield stability index (Bouslama

**Table 5. Categorization of sugarcane genotypes into tolerant and sensitive groups based on salinity tolerance index**

| Category | STI Value | Genotypes |
|---|---|---|
| Tolerant | 1.5-2.0 | Co 13035 (1.57), Co 14034 (1.68), CoS 767 (1.93), Co 15023 (1.96), Co 98014 (2.0) |
| Moderately Tolerant | 2.0-2.5 | Co 15027 (2.03), Co 1148 (2.15), Co 0238 (2.23), Co 15025 (2.23), Co 14036 (2.25), Co 0118 (2.25), Co 13036 (2.30), Co 12027 (2.35), Co 15026 (2.37) |
| Moderately Sensitive | 2.5-3.0 | Co 05011 (2.52), Co 14035 (2.52), Co 12029 (2.62), Co 11027 (2.63), Co 13034 (2.66), Co 05009 (2.86) |
| Sensitive | >3.0 | Co 12026 (3.05), Co 13033 (3.11), Co 06034 (3.17), Co 0237 (3.54) |

STI – Salinity tolerant index

& Schapaugh, 1984); Yield index (Gavuzzi et al., 1997); Stress tolerance index (Fernandez, 1992); Geometric mean productivity (Fernandez, 1992); Stress susceptibility index (Fischer & Maurer, 1978); Mean productivity (Rosielle & Hamblin, 1981); Tolerance index (Rosielle & Hamblin, 1981) etc. All the above mentioned indices/index are derived from yield only but in reality yield is a complex trait where several contributing dependents/independents traits plays role in the final expression of the yield. The magnitude of yield contributing traits under various stress levels and normal conditions varies. So to classify the genotypes into true tolerance and sensitive classes an index *viz*., Salinity Tolerance Index (STI) was developed. There was significant reduction in the expression of cane yield, NMC, SCW, Cane height, Cane Diameter, Juice extraction and tiller population at different levels of salinity. The maximum reduction was observed at 12 $EC_{iw}$ level of salinity. Hence the STI was derived by adding up the percent reduction in the expression of six yield traits *viz*., Cane yield, NMC, SCW, Cane height, Cane diameter, Juice extraction and tiller population at 12 $EC_{iw}$ compare to normal $EC_{iw}$ level. The sum was divided by 100 and the genotypes were categorised into tolerant, moderately tolerant, moderately sensitive and sensitive categories based on STI values (Table 5). Five genotypes Co 13035, Co 14034, CoS 767, Co 15023 and Co 98014 found tolerant and nine genotypes viz., Co 15027, Co 1148, Co 0238, Co 14036, Co 0118, Co 13036, Co 12027 and Co 15026 were moderately tolerant, whereas Co 12026, Co 13033, Co 06034 and Co 0237 were the sensitive genotypes to salinity. The tolerant and moderately tolerant varieties *viz*., Co 98014, Co 0238 and Co 0118 can be promoted for cultivation in salinity affected area of NWZ, whereas other tolerant Co canes can be tested under endemic salinity area and if any among them gets varietal status can be promoted for cultivation. All the tolerant and moderately tolerant genotypes can be utilized in breeding programme towards development of salinity tolerant sugarcane varieties for affected area.

## Genealogical base of salinity tolerance

The pedigree of 14 of the clones which were either tolerant (T) or moderately tolerant (MT) to salinity indicating that parent Co 8347 and Co 0241 appeared as one of the immediate parents in the pedigree of seven tolerant/moderately tolerant genotypes. Co 8347 contributed gametes as pollen parent to five genotypes viz., Co 14034 (Co 0241 x Co 8347), Co 15023 (Co 0241 x Co 8347), Co 15025 (Co 0241 x Co 8347), Co 15026 (Co 0124 x Co 8347), Co 13036 (Co 0240 x Co 8347) and as pistil parent to Co 0118 (Co 8347 x Co 86011). Co 0241 in addition to Co 14034, Co 15023 and Co 15025, is also pistil parent of Co 14036 (Co 0241 x Co 94008). The pedigree of rest of the T/MT clones and Moderately Sensitive/ Sensitive clones did not reflect clear-cut pattern of appearance of particular parent. Since half of the T/MT genotypes are developed by using Co 8347 and Co 0241 as either one or both the parents, these parents can be further utilised in breeding salinity tolerant varieties.

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