



## **Screening of Aggregatum Onion Varieties for Sodicity Tolerance**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

Sodicity is a major factor affects crop growth and productivity at global level. In the cultivable and at global level, 23% is affected by salinity and 37% land by sodicity. Two seed propagating aggregatum onion varieties (CO 5, CO 6) and two bulb propagating aggregatum onion varieties (Permbalurlocal, thuraiyurlocal) were screened by employing germination test in an osmotic solution of NaHCO<sub>3</sub> (Sodium bicarbonate). Three Replications of 20 seeds of each variety were counted and distributed over two layers of paper towel (21x21 cm) previously moistened with water equivalent to three times the dry weight of the paper and tied both ends with rubber band and kept in a plastic tray with different concentrations (0, 10 mM, 20 mM, 30 mM, 40 mM, 50 mM) of NaHCO<sub>3</sub> (sodium bicarbonate). Also another bulb propagated varieties, perambalur and thuraiyur local varieties bulb directly sown in beaker have 1.5 kg sand. Control beaker irrigated with only water and other beakers irrigated with different concentrations (25 mM, 50 mM, 75 mM and 100

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mM) of sodium bicarbonate solution. Germination percentage was recorded 7 days after. At the end of the 21th day, in four aggregatum onion varieties where final germination per cent, root length, shoot length, vigour index, stress tolerant index, relative water content and membrane stability index, were recorded in NaHCO<sub>3</sub> solution as against the distilled water was calculated. The experiment was designed as a completely randomized design with two factors. As a result a decline in all onion growth parameters, with increasing sodicity stress has been recorded. Significant differences were observed between the varieties and different NaHCO<sub>3</sub> concentrations. Irrespective of NaHCO<sub>3</sub> concentrations two seed propagating aggregatum onion varieties, CO 6 recorded significantly maximum stress tolerant index compare with CO 5 and two bulb propagating aggregatum onion varieties, Thuraiyur local variety recorded significantly maximum stress tolerant index compare with Perambalur local in all sodicity concentration. Based on stress tolerant index, CO 6 and thuraiyur local variety tolerant to sodicity stress and CO5, perambalur local variety susceptible to sodicity stress.

**Keywords:** Sodicity; NaHCO<sub>3</sub> (sodium bicarbonate); perambalur local; thuraiyur local; relative water content.

## 1. INTRODUCTION

“Sodicity is a major factor affects crop growth and productivity at global level. According to the estimates, about one third of the irrigated land on the earth is affected by salt stress. Out of 1.5 billion ha of cultivable land at global level, 23% are affected due to salinity and 37% by sodicity. Salinity is caused due to high accumulation of Ca, Mg as well as sodium and then anions such as SO<sub>4</sub>, NO<sub>3</sub>, CO<sub>3</sub> and HCO<sub>3</sub>, Cl, etc. and sodicity is due to high accumulation of sodium in the soil” [1]. The pH of sodic soil more than eight, ESP is more than 15 and EC is less than 4. In Tamil Nadu 4.69 lakh ha area has been affected by different levels of salinity and sodicity. Tiruchirappalli is important district of Tamil Nadu have 11,165 ha of land affected by salinity and sodicity. In Tiruchirappalli district, Manikandam block are affected severely due to sodicity with an area of around 5000 acres.

Onion is one of the most important commercially grown vegetable crops in India. Aggregatum onion (*Allium cepa* var. *aggregatum*) also known as multiplier onions or small onion, most important commercial vegetable crops grown in Southern India and Tamil Nadu. Aggregatum onion is sensitive to sodicity stress during its earlier growth stages and its later growth stages. When aggregatum onion is to long term sodic stress, yield is drastically reduced due to premature senescence of leaves. Screening and identification of aggregatum onion varieties starting sodicity tolerance will decrease the economic loss caused by sodicity

India is the second largest producer of onion after china with an annual production of 55 lakh

tonnes in 5.3 lakh hectares. In Tamil Nadu onion is cultivated in 28,000 hectares with a total production value of 3 lakh tonnes. Onion is an ancient crop that is believed to be originated in Central Asia, and has been under cultivation for over 5000 years. In addition “onion is added as an important spice ingredient in foods, soups, salads and stews. It is rich in vitamin E and has a myriad of therapeutic properties including the prevention of age- dependent changes in the blood vessels, loss of appetite, treatment of bacterial infections such as dysentery, management of ulcers, wounds, scars, asthma and also as an adjuvant therapy for diabetes” [2]. Selenium level in onion was found to be 0.024 µg g<sup>-1</sup>, which plays important role in the health and immune system. Antioxidants in onion lowers oxidative stress suppress inflammation and enhance immunity. Sodium toxicity can be seen as necrosis of leaf tips and plant yellowing in onions. Sodicity cause onion tip burning symptom and affect the onion bulb formation.

## 2. MATERIALS AND METHODS

The study was conducted at Horticultural College and Research Institute for Women (HC&RI (W)), Trichy during 2021. The method suggested by Kumar, P. A et al. [3] was followed to screen the aggregatum onion varieties against sodicity stress environment under laboratory condition. Two seed propagating aggregatum onion varieties (CO 5, CO 6) and two bulb propagating aggregatum onion varieties (Perambalur local, thuraiyur local) were screened by employing germination test in an osmotic solution of NaHCO<sub>3</sub> (Sodium bicarbonate). Two varieties (CO 5, CO 6) are seeds were allowed to germinate in distilled water (control). Three

Replications of 20 seeds of each variety were counted and distributed over two layers of paper towel (21x21cm) previously moistened with water equivalent to three times the dry weight of the paper and tied both ends with rubber band and kept in a plastic tray with different concentrations (0, 10 mM, 20 mM, 30 mM, 40mM, 50 mM) of Na<sub>2</sub>HCO<sub>3</sub> (Sodium bicarbonate). Also another bulb propagated varieties, perambalur and thuraiyur local varieties bulb directly sown in beaker have 1.5 kg sand. Control beaker irrigated with water and other beakers irrigated with different concentrations (25mM, 50mM, 75mM and 100mM) of Na<sub>2</sub>HCO<sub>3</sub> solution. Germination percentage was recorded 7 days after. At the end of the 21<sup>th</sup> day, in four aggregatum onion varieties where final germination per cent, root length, shoot length, vigour index, stress tolerant index, relative water content and membranest ability index, were recorded in NaHCO<sub>3</sub> solution as against the distilled water was calculated.

### 2.1 Vigour Index

The vigour index of the seedlings are calculated using the following formula proposed by Abdul-Baki and Anderson (1973) and expressed as per cent

Vigour Index = (Shoot length + Root length) x Germination percentage

### 2.2 Stress Tolerance Index

Stress tolerance index was calculated using the following formula proposed by Dhopte and Livera (1989) and expressed as per cent.

Stress tolerance index = Vigour index of the treated seedling / Vigour index of the control seedling x 100

### 2.3 Membrane Stability Index

The Membrane stability index was estimated according to Sullivan (1960). This experiment was carried out to determine the extent of membrane damage in tissues subjected to sodicity stress. In membrane stability index, the total inorganic ions (mainly K<sup>+</sup>) leaked out, is measured in terms of electrical conductivity (EC) of the bathing medium before and after the treatment, using a conductivity bridge. Leaf discs (about 20) of the test sample where taken in a test tube 10 ml of deionised water. The test tubes are covered and subjected to two high

temperature regimes (450C and 550 C) for 30 minutes, usually in a water bath. In practice, an initial EC, just before transfer to the high temperature treatment is taken. The EC determined is recorded (Eca). After 30 minutes, the EC is again measured (Ecb). After this the tubes are boiled at 1000 C for 10 minutes and the EC again recorded (Ecc).

$$\text{Percent leakage} = \frac{\text{Ecb} - \text{Eca}}{\text{Ecc}} \times 100$$

### 2.4 Relative Water Content

The relative Water Content (RWC) was estimated according to Barrs and Weatherly (1962) and calculated by using following formula and expressed as per cent.

RWC = [(Fresh weight – Dry weight) / (Turgid weight – Dry weight)] x 100

The experiment was designed as a completely randomized design with two factors. The first factor was the varieties and the second one is external sodicity stress. A seed was considered to be germinated when the emerging radicle elongated to 1 mm. Radicle length and hypocotyl length were calculated as described by Uniyaleet al.[4]. Analysis of variance was carried out as described by Steel et al.[5]. Statistical significance of means was tested by Completely Randomised Design.

## 3. RESULTS AND DISCUSSION

The analysis of variance showed significant differences among the genotypes and treatments. Significant differences were observed under different NaHCO<sub>3</sub> concentrations of 0 mM, 10 mM, 20 mM, 30 mM, 40 mM, 50mM.

### 3.1 Germination Percentage

The germination percentage of two aggregatum onion (seeds) varieties varied from 96 to 94 with average germination percentage of 95 under control (Table 1). While observing the effect of different sodicity stresses imposed using sodium bicarbonate at 10, 20, 30, 40 and 50 mM levels on germination percentage, greater reduction was noticed at the sodicity of 50 mM. At this level of sodicity, the variety CO 6 (31.7per cent) showed less reduction in germination percentage and CO 5 showed highest reduction in germination percentage (47.6per cent) over the control.

The impact of sodicity stresses on germination percentage of four aggregatum onion varieties screened through laboratory experiment was assessed. A decline in seed germination percentage with increasing sodicity stress has been recorded (Table 1). Among two seed propagating aggregatum onion varieties, CO 6 recorded significantly maximum vigour index compared with CO 5 and two bulb propagating aggregatum onion varieties, thuraiyur local variety recorded significantly maximum vigour index compared with Perambalur local in all sodicity concentration (0 mM, 10 mM, 20 mM, 30 mM, 40 mM, 50 mM) .At maximum sodicity concentration 50 mM (NaHCO<sub>3</sub>), the varieties CO 6 and thuraiyur local variety exhibited maximum (65.6%, 58.4%) germination percentage and CO 5 and perambalur local variety exhibited minimum (49.3%, 48.4%) germination percentage values. It was observed that germination percentage with decreasing water potential of the environment probably was triggered by the low hydraulic conductivity where, NaHCO<sub>3</sub> makes water unavailable to seeds, affecting the imbibition process of the seed which is fundamental for germination. Results of the current study were in agreement with findings of El-Saifi et al. [6], Souguir et al. [7], Ravi et al. [8] and Alejandra et al. [9].

### 3.2 Root Length

“Root length is an important trait against sodicity stress in plant varieties, with longer root growth has resistant ability for salt. Sodic stress cause drought stress, while that condition Early and rapid elongation of roots is an important indication of tolerance. Ability of continued elongation of root under water stress and longer root length at deeper layer are useful in extracting water in upland conditions” [10]. Who

The high Na<sup>+</sup> as a result, water deficiency occurs around the root system of plants [11]. “The plant embryo grows at germination and progresses radicles that become the primary roots and penetrate down into the soil. After radicle emergence, hypocotyl emerges and lifts the growing tip above the ground. Under drought stress condition, the root develops faster than the hypocotyls to climatize the drought stress. Therefore, the growth of radical and hypocotyls should reflect the adapt ability of plant to drought stress” [12]. The root length of aggregatum onion (seed) varieties varied from 5.00 to 5.11 cm with average root length of 5.06 cm under control (Table 2.a). The greater reduction in root length was noticed at the sodicity of 50 mM. At this level of sodicity, the root length was 3.12 to 3.53 cm with average root length of 3.32 cm and an about average 34.6 percent reduction over the control was observed. Comparing the performance of varieties at the highest sodicity levels of 50mM, it could be observed that varieties CO 6 (30.9per cent) showed less reduction in root length and CO 5 showed highest reduction in root length (37.6per cent) over the control.

The average root length of aggregatum onion (bulb) varieties 9.80 cm under control (Table 2.b). While observing the effect of different sodicity stresses imposed using sodium bicarbonate on root length, greater reduction was noticed at the sodicity of 100 mM. At this level of sodicity, the average root length of 0.79 cm and an about average 91.9 percent reduction over the control was observed. Comparing the performance of varieties at the highest sodicity levels of 75mM, it could be observed that varieties thuraiyur local (86.2 %) showed less reduction in root length and perambalur local showed highest reduction in root length (97.65 %) over the control.

**Table 1a. Effect of different concentrations of NaHCO<sub>3</sub> on germination percentage of aggregatum onion seedlings**

Variety	Control	10 mM	20 mM	30 mM	40 mM	50 mM	Mean
Co 5	94.0	86.6	78.00	71.6	59.6	49.3	<b>73.1</b>
CO 6	96.0	90.3*	88.2*	84.3*	77.0*	65.6*	<b>83.2*</b>
<b>Mean</b>	<b>95.0</b>	<b>88.4</b>	<b>83.1</b>	<b>77.9</b>	<b>68.3</b>	<b>57.4</b>	<b>78.2</b>
	<b>SEd</b>			<b>CD(0.05)</b>			
<b>V</b>	0.72			1.48			
<b>S</b>	1.24			2.57			
<b>VS</b>	1.76			3.64			

**Table 1b. Effect of different concentrations of NaHCO<sub>3</sub> on germination percentage of aggregatum onion bulb**

Variety	Control	25mM	50mM	75mM	100mM	Mean
Perambalur local	100	86.6	46.6	26.6	12.6	54.4
Thuraiyur local	100	100	100	80.0	46.6	85.3
<b>Mean</b>	<b>100</b>	<b>93.3</b>	<b>73.3</b>	<b>53.3</b>	<b>29.5</b>	<b>69.8</b>

  

	SEd	CD(0.05)
<b>V</b>	0.49	1.02
<b>S</b>	0.78	1.62
<b>VS</b>	1.10	2.30

**Table 2a. Effect of different concentrations of NaHCO<sub>3</sub> on root length (cm) of aggregatum onion seedlings**

Variety	Control	10 mM	20 mM	30 mM	40 mM	50 mM	Mean
<b>Co 5</b>	5.00	4.89	4.52	3.85	3.32	3.12	4.08
<b>Co 6</b>	5.11	4.90	4.83	4.44	4.03	3.53	4.46
<b>Mean</b>	<b>5.06</b>	<b>4.89</b>	<b>4.68</b>	<b>4.14</b>	<b>3.67</b>	<b>3.32</b>	<b>4.27</b>

  

	SEd	CD(0.05)
<b>V</b>	0.03	0.07
<b>S</b>	0.06	0.13
<b>VS</b>	0.09	0.19

**Table 2b. Effect of different concentrations of NaHCO<sub>3</sub> on root length (cm) of aggregatum onion bulb**

Variety	Control	25mM	50mM	75mM	100mM	Mean
Perambalur local	9.80	7.40	2.95	0.40	0.23	4.15
Thuraiyur local	9.80	8.60	6.03	1.93	1.34	5.54
<b>Mean</b>	<b>9.80</b>	<b>8.00</b>	<b>4.49</b>	<b>1.17</b>	<b>0.79</b>	<b>4.85</b>

  

	SEd	CD(0.05)
<b>V</b>	0.03	0.06
<b>S</b>	0.05	0.10
<b>VS</b>	0.07	0.14

### 3.3 Shoot Length

The shoot length of aggregatum onion (seed) varied from 6.8 to 7.0 cm with average shoot length of 7.11 cm under control (Table 3.a). While observing the effect of different sodicity stresses imposed using sodium bicarbonate at 10, 20, 30, 40 and 50 mM levels on shoot length, greater reduction was noticed at the sodicity of 50 mM. At this level of sodicity, the shoot was 5.0 to 5.9 cm with average shoot length of 5.4 cm and an about average 20.6 percent reduction was observed. Comparing the performance of varieties at the highest sodicity levels of 50mM, it could be observed that varieties CO 6 (15.7per cent) showed less reduction in shoot length and

CO 5 showed highest reduction in germination percentage (26.5per cent) over the control.

The shoot length of two aggregatum (bulb) onion was 23.8 to 24.0 cm with average shoot length of 23.90 cm under control (Table 3.b). While observing the effect of different sodicity stresses imposed using sodium bicarbonate, the greater reduction in shoot length was noticed at the sodicity of 100 mM. At this level of sodicity, the average shoot length of 1.0 cm and an about average 95.81 percent reduction was observed. Comparing the performance of varieties at the highest sodicity levels of 100 mM, it could be observed that varieties thuraiyur local (94.16 %) showed less reduction in shoot length and

perambalur local variety showed highest reduction in germination percentage (97.47 %) over the control.

### 3.4 Vigour Index

Vigour index is an important index for sodicity tolerance and significant varietal variations in vigour index was observed due to stress treatments (Table 4.a.).The vigour index of aggregatum onion (seed) varieties varied from 1109 to 1137 with average vigour index of 1123 under control. While observing the effect of different sodicity stresses imposed using sodium bicarbonate at 10, 20, 30, 40 and 50 mM levels on vigour index, greater reduction was noticed at the sodicity of 50 mM. At this level of sodicity, the vigour index was 399 to 616 with average vigour index of 507 and an about average 54.8 percent reduction over the control was observed. Comparing the performance of varieties at the highest sodicity levels of 50mM, it could be observed that varieties CO 6 (45.8per cent) showed less reduction in vigour index and CO 5 showed highest reduction in vigour index (64.02per cent) over the control.

The vigour index of aggregatum onion (bulb) varieties varied from 3360 to 3380 with average vigour index of 3370 under control (Table 4.b). While observing the effect of different sodicity stresses imposed using sodium bicarbonate at 25, 50, 75 and 100 mM levels on vigour index, greater reduction was noticed at the sodicity of 100 mM. At this level of sodicity, the average vigour index of 68.09 and an about average 97.97 percent reduction over the control was observed. Comparing the performance of varieties at the highest sodicity levels of 100 mM, it could be observed that varieties thuraiyur local (96.22 per cent) showed less reduction in vigour index and perambalur local showed highest reduction in vigour index (99.69 per cent) over the control.

### 3.5 Stress Tolerant Index

The stress tolerance index (STI) was calculated based on the vigour index of the seedlings as per cent ratio between the values under different sodicity stress treatment and control. The results revealed that with the increase in sodicity level, there was a decreasing trend in STI in all the aggregatum onion (seed) varieties (Table 5.a.) The mean STI of varieties was reduced from 100 (control) to 90, 82, 71, 57 and 45 due to 10 mM, 20 mM, 30Mm,40mM and 50mM sodicity levels.

The individual variety differed significantly with respect to its STI at various levels of sodicity. At the highest sodicity level of 50 mM, CO 6 (45.9per cent) showed less reduction in STI and whereas the poor performing varieties, CO 5 showed highest reduction in STI (64.1per cent) over the control.

The results revealed that with the increase in sodicity level, there was a decreasing trend in STI in two aggregatum onion (bulb) varieties (Table 5.b) The mean STI of varieties was reduced from 100 (control) to 73.55, 41.67, 13.61 and 2.04 due to 25 mM, 50 mM, 75 mM and 100 mM sodicity levels. At the highest sodicity level of 100 mM, thuraiyur local (96.23per cent) showed less reduction in STI and whereas the poor performing varieties, perambalur local showed highest reduction in STI (99.7 per cent) over the control.

### 3.6 Relative Water Content

The relative water content of aggregatum onion (seed) varied from 81.0 to 84.0 per cent with average relative water content of 82.5 per cent under control (Table 6.a.). While observing the effect of different sodicity stresses imposed using sodium bicarbonate at 10, 20, 30, 40 and 50 mM levels on relative water content, greater reduction was noticed at the sodicity of 50 mM. At this level of sodicity, the relative water content was (55.0 to 58.0 per cent) with average relative water content of 56.5 per cent and an about average 31.5 percent reduction was observed. Comparing the performance of varieties at the highest sodicity levels of 50mM, it could be observed that varieties CO 6 (29.6per cent) showed less reduction in relative water content and CO 5 showed highest reduction in relative water content (32.09per cent) over the control.

The relative water content of aggregatum onion (bulb) was 78.0 and 79.0 per cent with average relative water content of 78.5 per cent under control (Table 6.b). While observing the effect of different sodicity stresses imposed using sodium bicarbonate at 25, 50, 75 and 100 mM levels on relative water content, greater reduction was noticed at the sodicity of 100 mM. At this level of sodicity, the average relative water content of 65.0 per cent and an about average 17.19 percent reduction over the control was observed. Comparing the performance of varieties at the highest sodicity levels of 100 mM, it could be observed that varieties thuraiyur local (13.9 %) showed less reduction in relative water content

and perambalur local showed highest reduction in relative water content (20.50 %) over the control. Under such forced water deficiency environment, leaf relative water content reduced, [13] and allow “to retain the excess amount of water to regulate the desired rate of metabolism

during the spell of draught stress (desiccation period) around the roots as well in leaf tissues” [14].allow “to retain the excess amount of water to regulate the desired rate of metabolism during the spell of draught stress (desiccation period) around the roots as well in leaf tissues” [14].

**Table 3a. Effect of different concentrations of NaHCO<sub>3</sub> on shoot length (cm) of aggregatum onion seedlings**

Variety	Control	10 mM	20 mM	30 mM	40 mM	50 mM	Mean
Co 5	6.8	6.5	6.3	5.9	5.5	5.0	5.9
CO 6	7.0*	6.8*	6.6*	6.4*	6.1*	5.9*	6.4*
<b>Mean</b>	<b>6.8</b>	<b>6.6</b>	<b>6.4</b>	<b>6.1</b>	<b>5.7</b>	<b>5.4</b>	<b>6.2</b>
	<b>SEd</b>			<b>CD(0.05)</b>			
<b>V</b>	0.04			0.09			
<b>S</b>	0.07			0.15			
<b>VS</b>	0.10			0.22			

**Table 3b. Effect of different concentrations of NaHCO<sub>3</sub> on shoot length (cm) of aggregatum onion bulb**

Variety	Control	25mM	50mM	75mM	100mM	Mean
Perambalur local	23.8	13.9	11.0	3.1	0.6	10.4
Thuraiyur local	24.0	22.6	15.6	8.4	1.4	14.4
<b>Mean</b>	<b>23.90</b>	<b>18.25</b>	<b>13.30</b>	<b>5.75</b>	<b>1.00</b>	<b>12.40</b>
	<b>SED</b>			<b>CD(0.05)</b>		
<b>V</b>	0.12			0.25		
<b>S</b>	0.19			0.39		
<b>VS</b>	<b>0.26</b>			<b>0.56</b>		

**Table 4a. Effect of different concentrations of NaHCO<sub>3</sub> on vigour index of aggregatum onion bulb**

Variety	Control	10mM	20mM	30mM	40mM	50 mM	Mean
CO 5	1109	978	842	694	524	399	757.6
CO 6	1137	1056*	1005*	910*	777*	616*	916.8*
<b>Mean</b>	<b>1123</b>	<b>1016</b>	<b>923</b>	<b>802</b>	<b>650</b>	<b>507</b>	<b>837</b>
	<b>SED</b>			<b>CD(0.05)</b>			
<b>V</b>	7.34			15.16			
<b>S</b>	12.72			26.26			
<b>VS</b>	17.9			37.14			

**Table 4b. Effect of different concentrations of NaHCO<sub>3</sub> on vigour index of aggregatum onion bulb**

Variety	Control	25mM	50mM	75mM	100mM	Mean
Perambalur local	3360	1844.5	650.0	94.6	10.2	1191.9
Thuraiyur local	3380	3120.0	2163.0	826.4	127.6	1923.4
<b>Mean</b>	<b>3370</b>	<b>2482</b>	<b>1406.5</b>	<b>460.5</b>	<b>68.09</b>	<b>1557.0</b>
	<b>SED</b>			<b>CD(0.05)</b>		
<b>V</b>	22.7			47.4		
<b>S</b>	35.9			74.9		
<b>VS</b>	50.8			106.0		

**Table 5a. Effect of different concentrations of NaHCO<sub>3</sub> on stress tolerant index of aggregatum onion bulb**

Variety	Control	10mM	20mM	30mM	40mM	50 mM	Control
CO 5	100	88.1	75.9	62.5	47.0	35.9	68.2
CO 6	100	92.8 <sup>*</sup>	88.3 <sup>*</sup>	80.0 <sup>*</sup>	68.3 <sup>*</sup>	54.1 <sup>*</sup>	80.5 <sup>*</sup>
<b>Mean</b>	<b>100</b>	<b>90.4</b>	<b>82.0</b>	<b>71.2</b>	<b>57.6</b>	<b>44.9</b>	<b>74.4</b>
		<b>SED</b>			<b>CD(0.05)</b>		
<b>V</b>		0.49			1.01		
<b>S</b>		0.85			1.75		
<b>VS</b>		1.20			2.48		

**Table 5b. Effect of different concentrations of NaHCO<sub>3</sub> on stress tolerant index of aggregatum onion bulb**

Variety	Control	25mM	50mM	75mM	100mM	Mean	
Perambalur local	100	54.8	19.3	2.8	0.3	35.5	
Thuraiyur local	100	92.3	63.9	3.7	3.7	556.9	
<b>Mean</b>	<b>100</b>	<b>73.5</b>	<b>41.6</b>	<b>2.0</b>	<b>2.0</b>	<b>46.1</b>	
		<b>SED</b>			<b>CD(0.05)</b>		
<b>V</b>		0.49			1.02		
<b>S</b>		0.78			1.62		
<b>VS</b>		1.10			2.30		

**Table 6a. Effect of different concentrations of NaHCO<sub>3</sub> relative water content (%) of aggregatum onion seedlings**

Variety	Control	10 mM	20 mM	30 mM	40 mM	50 mM	Mean
Co 5	81.0	79.0	66.0	63.0	58.0	55.0	66.9
CO 6	84.0	80.0	77.0	71.0	60.0	58.0 <sup>*</sup>	71.6 <sup>*</sup>
<b>Mean</b>	<b>82.5</b>	<b>79.5</b>	<b>71.5<sup>*</sup></b>	<b>67.0<sup>*</sup></b>	<b>59.0</b>	<b>56.5</b>	<b>69.33</b>
		<b>SEd</b>			<b>CD(0.05)</b>		
<b>V</b>		0.50			1.04		
<b>S</b>		0.88			1.81		
<b>VS</b>		1.24			2.56		

**Table 6b. Effect of different concentrations of NaHCO<sub>3</sub> on relative water content (%) of aggregatum onion bulb**

Variety	Control	25mM	50mM	75mM	100mM	Mean	
Perambalur local	78.0	73.0	70.0	69.0	62.0	70.4	
Thuraiyur local	79.0	75.0	72.0	70.0	68.0	72.8	
<b>Mean</b>	<b>78.5</b>	<b>74.0</b>	<b>71.0</b>	<b>69.5</b>	<b>65.0</b>	<b>71.6</b>	
		<b>SEd</b>			<b>CD(0.05)</b>		
<b>V</b>		0.58			1.22		
<b>S</b>		0.91			1.93		
<b>VS</b>		1.29			2.72		



**Table 7a. Effect of different concentrations of NaHCO<sub>3</sub> membrane stability index of aggregatum onion seedlings**

Variety	Control	10 mM	20 mM	30 mM	40 mM	50 mM	Mean
Co 5	73.0	72.1	68.1	64.8	57.8	51.4	64.5
CO 6	74.2	71.5	69.2	66.6	62.3*	58.2*	67*
Mean	73.6	71.8	68.6	65.6	60.0	54.7	65.7

  

	SEd	CD(0.05)
V	0.67	1.38
S	1.16	2.40
VS	1.64	3.40

**Table 7b. Effect of different concentrations of NaHCO<sub>3</sub> on membrane stability index of aggregatum onion bulb**

Variety	Control	25mM	50mM	75mM	100mM	Mean
Perambalur local	70.58	62.3	61.1	58.8	51.8	60.9
Thuraiyur local	71.24	66.4	63.4	61.6	57.3	63.9
Mean	70.9	64.3	62.2	60.2	54.0	62.4

  

	SEd	CD(0.05)
V	0.55	1.15
S	0.87	1.81
VS	1.23	2.57

#### 4. CONCLUSION

The impact of sodicity stresses on four aggregatum onion varieties screened through laboratory experiment was assessed. As a result a decline in all onion growth parameters, germination per cent, root length, shoot length, vigour index, stress tolerant index, relative water content and membrane stability index with increasing sodicity stress has been recorded. Significant differences were observed between the varieties and different NaHCO<sub>3</sub> concentrations. Irrespective of NaHCO<sub>3</sub> concentrations, CO 6 and thuraiyur local variety recorded maximum value in all growth parameters compared to other varieties CO 5 and perambalur local. Based on stress tolerant index result concluded, CO 6 and thuraiyur local variety tolerant to sodicity stress and CO 5, perambalur Local variety susceptible to sodicity stress.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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