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Evaluation of okra [*Abelmoschus esculentus* L.) Moench] varieties and hybrids under varying salinity levels

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ABSTRACT

Salinity produces changes in morphological traits, physiological and biochemical processes, as well as anatomical changes that limit root growth and reduce shoot growth. Performance of 25 okra genotypes, consisting of 10 OP varieties and 15 hybrids, was evaluated for different growth and yield component traits under four salinity stressed conditions (50 mM NaCl, 100 mM NaCl, 150 mM NaCl and 200 mM NaCl) along with a control. It was observed that Mayna (F_1), Gunjan (F_1) and Arka Anamika (OP) showed early germination under all the salinity levels. Novo-62 (OP) showed the highest germination percentage and plant height was high in Mayna (F_1) under all the salinity levels. Shivani (F_1) recorded the maximum internodal length whereas Rohini 1001 (F_1) recorded the least node number at which first flower appeared. Mayna (F_1) took the least number of days to produce first flowering in 50% population under all the salinity levels and Japani Jhar (OP) recorded the maximum leaf length. Mayna (F_1) recorded the earliest fruit formation under all the salinity levels except control, where, Gunjan took the least number of days. Maximum fruit length was observed in Mayna (F_1), while maximum fruit girth was observed in Japani Jhar (OP), Arka Ankita (F_1), Shakti (F_1) and Novo-62 (OP). Highest number of fruits per plant and maximum fruit weight was observed in Mayna (F_1). Both Rohini (F_1) and Divya-192 (F_1) showed the highest value of 1000-seed weight. Maximum fruit yield was observed in Mayna (F_1) under all the salinity levels except under 100 mM NaCl. Total chlorophyll content in fruit decreased with increased salinity level and Mayna (F_1) showed the higher retention of chlorophyll. Total phenol content in fruit increased with increased level of salinity. Mayna (F_1) showed the highest level of total phenols under 200 mM NaCl. Mayna (F_1) and Gunjan (F_1) performed better with respect to salinity tolerance based on growth, yield components and fruit yield per plant. These two hybrids might be suggested in areas where growing okra is severely hampered by saline levels.

Keywords: Okra, salinity, growth, yield, quality

INTRODUCTION

The most harmful abiotic stress is salinity stress, which has a significant negative impact on plant growth and development and limits crop performance to only 30% of its genetic potentiality. This stress causes nearly 50% of yield reduction and appears to pose a potential threat to the world's food security in the coming decades.Numerous areas of land are plagued by salinity, and this issue is getting worse. Salinity has an impact on more than 30% of irrigated land and 6% of all land (Parihar *et al.,* 2015). Salinity tolerance in plants is mostly influenced by the environmental condition and also varies among different plant species. Salinity is the condition in which concentration of dissolved inorganic salts in the soil or water increases beyond the tolerance level which includes K^+, Mg^{2+}, Ca^{2+} and Na^+ cations whereas anions include NO^{3-}, $CO3^{2-}$, $SO4^{2-}$, HCO^{3-} and Cl^-. Other components which are present in the highly saline soil are Al^{3+}, Mo, Ba^{2+}, B, Sr^{2+} and SiO_2 (Manchanda and Garg, 2008). High salt concentrations can have two different effects on plants. In the beginning, it can limit the ability of roots to draw water from the soil or it can cause ion toxicity within the plant, which inhibits a variety of biochemical and physiological processes (Munns and Tester, 2008). Some major activities within a plant like photosynthesis, protein synthesis and lipid metabolism are affected during the onset and development of salinity stress. Due to the osmotic effect of the saline solution close to the root zone, which makes it challenging for the root to absorb water, plant development declined during the initial phase. As a result, the rate of shoot growth also dropped. Salt stress also inhibits the uptake of major nutrients

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like potassium and calcium and ceased root tip expansion (Larcher, 1980). In the second phase, plants which are sensitive to salinity have decreased photosynthetic capacity. It occurs due to accumulation of toxic ions specially Na^+ in the leaf blade. Old leaves die as a result of this toxic Na^+, which is especially true for old leaves. However, the rate at which new leaves are produced is lower than the rate at which older leaves die, and as a result, the young leaves are no longer provided with the necessary carbohydrates, which slows down their rate of growth (Munns and Tester, 2008). High Sodium accumulation in plants leads to the increased production of reactive oxygen species which are rapidly taken out by antioxidative defense mechanisms (Foyer and Noctor, 2003). Under salinity stress ROS functions in both ways firstly, as toxic byproducts of stress metabolism and also as important signal transduction molecule in the networks of calcium mediated stress response pathway (Miller *et al.,* 2010). Okra (*Abelmoschus esculentus*), belonging to the family Malvaceae, is extensively grown in the tropical and subtropical parts of the world (Tindall, 1983). A 90% loss ($6.5 dsm^{-1}$) in okra yield has been reported under high salt levels worldwide (Mushtaq *et al.,* 2020). Use of underground saline water for irrigation is one of the causes of salt deposition in the crop apart from these industrial effluents in the canal used for irrigation also serves as a source of salts in irrigation water. Application of this saline water to the crop decreases the rate of transpiration which leads to the disruption of evapo-transpiration rate and causes yield reduction (Dudley *et al.,* 2008). Being moderately salt tolerant crop okra could tolerate the salinity level up to 2 dSm^{-1} or 20 mM l^{-1}(Gupta and Minhas, 1993; Abid *et al.,*2002).Thus, to identify salt tolerant genotypes more credibly evaluation of plant genotypes needs to be done at every stage of plant ontogeny starting from the germination till its reproductive phase. According to the mathematical relationship between control and stress conditions, several selection indices have been identified, these salt tolerance indices have found to be useful in estimating salinity stress level and for selection of tolerant elite genotypes. The aforesaid potential lines can be used in breeding programme or may serve as source of candidate-gene responsible for salt tolerance, required for crop improvement in saline soil. Keeping this in view, a study was initiated to screen out twenty-five okra genotypes on the basis of their salt tolerance potential.

MATERIALS AND METHODS

The present experiment was carried out at Agricultural Experimental Farm, University of Calcutta, situated at Baruipur, South 24 Parganas, West Bengal during summer-rainy seasons of 2018 to 2020. Twenty-five accessions (Table1) of okra consisting of 10 OP varieties and 15 hybrids were examined in polybags. Small holes were punched into the upper and lower portions of black polythene bags measuring 18″ by 12″ to allow for proper aeration and the leaching of extra irrigation water. These packets were filled with mixture of soil and sand in 2:1 ratio and a handful of vermicompost and light irrigation were given to make the soil wet and kept in sunlight for 3-5 days. Pre-soaked seeds of genotypes were sown in polybags having three replications, ensuring 10 plants under each treatment. Requisite amount of NaCl salt solution was added to raise the desired salinity level as per our plan of work. The salt solution prepared in Hoagland base (Table 2a and 2b) and applied to the polybag soil with a 50 mM basal dose was gradually increased on a regular basis up to 200 mM. Salinity levels viz. 50 mM NaCl (T_1), 100 mM NaCl (T_2), 150 mM NaCl (T_3), 200 mM NaCl (T_4) and control (T_5) were considered as treatments. All the plants were selected from each of these treatments to evaluate the quantitative characters.

Data were recorded on days to first germination, germination percentage (%), plant height (cm), number of branches per plant, internodal length (cm), node number to which first flower appeared, days to 50% flowering, number of leaves per plant, leaf length (cm), days to attain edible fruit maturity, fruit length (cm), fruit diameter (cm), number of fruits per plant, fruit weight (g), 1000-seed weight (g), fruit yield per plant (g), total phenol content (mg GAE/g DW) and total chlorophyll content (mg/100 g) in fruits. Total chlorophyll content was estimated following Arnon method (Arnon, 1949). The concentrations of total chlorophyll

Table 1: List of okra genotypes along with their place of collection

Name of the genotype	Place of collection
Shakti (F_1)	Bayer, Jharkhali, South 24 Parganas, W.B.
Samrat (F_1)	Bayer, Jharkhali, South 24 Parganas, W.B.
Sartaj (F_1)	Bayer, Jharkhali, South 24 Parganas, W.B.
Rohini 1001 (F_1)	Nuzivedu, Raidighi, South 24Parganas, W.B.
Gunjan (F_1)	Kalash, Kakdweep, South 24 Parganas, W.B.
Raj-333 (F_1)	Pear, Kakdweep, South 24 Parganas, W.B.
Divya-192 (F_1)	Calyx, Kakdweep, South 24 Parganas, W.B.
Arka Ankita (F_1)	Shriram, Amtala, South 24 Parganas, W.B.
Jhimli (F_1)	Shriram, Amtala, South 24 Parganas, W.B.
Hybrid-302 (F_1)	Bio-seed, Bhangar, South 24 Parganas, W.B.
Special Hariyali (F_1)	JK seed, Bhangar, South 24 Parganas, W.B.
Durga (F_1)	JK seed, Kakdweep, South 24 Parganas, W.B.
Raj Vendi (F_1)	PAN, Bhangar, South 24 Parganas, W.B.
Mayna (F_1)	Mahyco, Amtala, South 24 Parganas, W.B.
Shivani Hybrid (F_1)	Rashi seed, Raidighi, South 24 Parganas, W.B.
Arka Anamika (OP)	Annapurna, Amtala, South 24 Parganas, W.B.
Suhani (OP)	Shriram, Amtala, South 24 Parganas, W.B.
Novo-62 (OP)	Novo, Kakdweep, South 24 Parganas, W.B.
Vaner (OP)	Golden, Jharkhali, South 24 Parganas, W.B.
Jhar Pankaj (OP)	Debgiri, Jharkhali, South 24 Parganas, W.B.
Satdhari (OP)	Bakra, Jharkhali, South 24 Parganas, W.B.
Japani Jhar (OP)	A.K. Laskar& Co., Jharkhali, South 24 Parganas, W.B.
Calyx- 303 (OP)	Calyx, Kakdweep, South 24 Parganas, W.B.
Adharsa Jhar (OP)	Indo-Hybrid, Amtala, South 24 Parganas, W.B.
Super Green (OP)	V.N.R., Bhangar, South 24 Parganas, W.B.

Table 2a: Composition of Hoagland solution

Salt Solution	g/100 ml
$Ca(NO_3)_2, 4H_2O$	23.61
KNO_3	10.11
KH_2PO_4	13.61
$MgSO_4, 7H_2O$	24.65
Trace Elements	g/100 ml
$MnCl_2$	0.28
$ZnSO_4, H_2O$	0.18
$CuSO_4$	0.022
Na_2MoO_4	0.01
Fe – EDTA	g/100 ml
EDTA, 2Na	1.04
$FeSO_4, 7H_2O$	0.78
KOH	5.61

were calculated using the following equation: Total Chlorophyll = 20.2 (A 645) + 8.02 (A 663) × Volume/1000 × Weight (where, A is absorbance). Total phenolic content was determined using the Folin-Ciocalteu method as described by Wei *et al*. (2010). The total phenolic content of the extract was calculated and expressed as milligram GA equivalents per gram of dry weight (mg GAE/g DW) based on the GA standard curve (y=6.35A−0.052, R^2=0.9994, where y is the content in mg/ml and A is the absorbance).

The statistical analysis for various parameters was executed in the Department of Horticulture, Institute of Agricultural Science, University of Calcutta using the statistical package SPAR II (ICAR-IASRI) utilizing the pooled data over the years.

Table 2b: Working concentration of Hoagland solution

Component	Volume for 1000 ml solution
$Ca(NO_3)_2, 4H_2O$	7 ml
KNO_3	5 ml
KH_2PO_4	2 ml
$MgSO_4$, & H_2O	2 ml
Trace Elements	1 ml
6. Fe- EDTA	1 ml

RESULTS AND DISCUSSION

Morphological traits

It was observed that days to first germination (Table 3), gradually increased with increase in salinity level. Under all salinity levels except control, Mayna (F_1) had the earliest days to first germination, although Arka Anamika (OP) did well. Younis *et al*. (1991) reported that low moisture content under salt stress condition cause cessation of metabolism or inhibition of certain steps in metabolic sequences of germination. Moreover, several reports suggest hyper-saline environment caused delayed germination by reducing hydrolytic enzyme activities and retarding the mobilization rate of metabolites (Prado *et al.,* 1995). Saline stress limits hydrolysis of food reserves from storage tissue and impairs their translocation from storage tissue to developing embryo axis (Dubey, 2005). Germination percentage (Table 3), decreased for all the genotypes under study with increased salinity levels.

The highest germination percentage was observed in Mayna (F_1) under control. Under 50 mM NaCl the maximum rate of germination was recorded in both Japani Jhar (OP) and in Mayna (F_1), while under 100 mM and 150 mM NaCl, Arka Anamika (OP) recorded the highest rate of germination. Under 200 mM NaCl, the highest germination percentage was found in Novo-62 (OP) while in Satdhari (OP) it was the least (Table 3). Reduction in germination percentage may be related to the reduced capacity of water absorption in germinating seeds under saline conditions. Our results also established the observations of Song *et al.* (2014); Zhang *et al.* (2012); Zehra *et al.* (2012), who observed a marked reduction in germination of *Suaeda salsa, Chloris virgate*, *Digitaria sanguinalis* and *Phragmites karka*. Mayna (F_1) exhibited the highest plant height (Table 3) under all the salinity levels. The maximum internodal length was recorded in Mayna (F_1) under 50 mM, 100 mM NaCl and control, while Shivani (F_1), Shakti (F1) and Samrat (F_1) under 150 mM NaCl, and Shivani (F_1) under 200 mM NaCl (Table 4). Rohini 1001 (F_1) produced first flower at the lowest node under 100, 150 and 200 mM NaCl. Arka Ankita (F1) under 50 mM NaCl and Divya-192 (F1), Shakti (F1) and Shivani (F1) under control recorded first flower at the lowest node (Table 4). Mayna (F1) took the least number of days to produce first flowering in 50% population under all the salinity levels (Table 4). Mayna (F1) recorded maximum number of leaves under control, 50 mM, and 100 mM NaCl whereas, Special Hariyali (F1) recorded maximum leaves under150 mM and 200 mM NaCl (Table 4). Japani Jhar (OP) recorded the highest leaf length under all the salinity levels (Table 5). The reduction in leaf length due to high salt contents was mainly as a result of the osmotic effect of saline water. Leaf cells loose water because of an abrupt increase in soil salinity levels (Salik *et al.,* 2021). Mayna (F1) recorded the earliest fruit formation under all the salinity levels except control where Gunjan (F1) took the least number of days to attain edible fruit maturity (Table 5).

Yield and yield component traits

The maximum fruit length was observed in Mayna (F_1) under all the salinity levels (Table 6) and Japani Jhar (OP), Arka Ankita (F_1), Shakti (F_1) and Novo-62 (OP) had higher fruit diameter than the others (Table 6). The maximum number of fruits per plant was observed in Mayna (F_1) under all the salinity levels (Table 6). Maximum fruit weight was observed in Mayna (F_1) under all the salinity levels except under 150 mM NaCl and control (Table 7), in which, Arka Anamika (OP) and Jhimli (F_1) excelled well. Rohini (F_1) and Divya-192 (F_1) showed the highest value of 1000-seed weight among all the genotypes under different levels of salinity stress (Table 7). With the exception of 100 mM NaCl salinity level, where Raj Vendi (F_1) had the highest fruit yield per plant, Mayna (F_1) displayed the maximum fruit yield per plant over the treatments (Table 7). A few OP varieties, such as Arka Anamika, Suhani, Japani Jhar, and Novo-62, also outperformed several hybrids in terms of fruit yield when exposed to saline stress. Results suggest that there was a sharp decline in yield of all the cultivars under study with increased salinity levels. Similar reports were provided by earlier scientists (Odunnaike, 2011, Abbas *et al.,* 2014, Shahid *et al.,* 2011) who worked on okra

Table 3: Performance of 25 okra genotypes on days to first germination, germination percentage and plant height under different salinity levels

Variety/Hybrid	Days to first germination						Germination percentage (%)						Plant height (cm)					
	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean
Shivani (F_1)	5.3	5.8	6.2	6.5	4.2	5.6	81.0	66.0	57.4	46.7	84.5	67.1	43.0	38.0	35.0	31.0	49.4	39.3
Samrat (F_1)	5.6	6.0	6.4	6.6	4.4	5.8	75.3	57.2	48.0	42.0	91.0	62.7	42.1	37.4	33.0	32.0	51.2	39.1
Japani Jhar (OP)	5.7	6.0	6.5	6.7	4.5	5.9	84.0	68.0	62.4	57.0	90.5	72.4	44	38	35.1	31.2	53	40.3
Rohini (F_1)	5.8	6.0	6.6	6.8	4.6	6.0	68.4	67.3	57.0	57.3	81.4	66.3	43.0	37.5	32.0	30.1	49.0	38.3
Gunjan(F_1)	5.7	5.8	6.2	6.4	4.4	5.7	81.0	72.0	46.0	58.0	92.0	69.8	43.3	38.0	34.0	31.0	52.6	39.8
Raj-333 (F_1)	5.8	5.9	6.6	6.9	4.7	6.0	69.4	48.4	47.3	57.7	75.6	59.7	41.6	35.0	31.1	29.1	50.0	37.3
Divya-192 (F_1)	5.9	6.2	6.7	7.2	4.9	6.2	73.0	61.0	61.0	36.6	81.0	62.5	42.0	36.3	33.0	30.0	51.3	38.5
Arka Ankita(F_1)	5.6	6.1	6.8	6.9	4.8	6.0	72.0	58.6	52.5	47.0	82.5	62.5	41.0	34.0	32.0	27.0	46.2	36.0
Arka Anamika (OP)	4.3	5.7	6.2	6.7	3.9	5.4	83.3	73.0	71.0	48.0	92.2	73.5	43.4	37.7	32.1	28.1	48.2	37.9
Jhimli (F_1)	5.8	6.1	6.6	7.2	4.9	6.1	62.0	60.0	56.0	56.0	68.0	60.4	41.1	35.2	34.2	29.4	50.0	38.0
Hybrid-302(F_1)	6.2	6.8	7.2	7.5	5.2	6.6	63.0	55.3	48.0	32.4	64.5	52.7	44.5	34.0	32.0	28.0	47.0	37.1
Special Hariyali(F_1)	6.3	6.6	7.3	7.5	4.9	6.5	62.4	61.0	55.3	31.0	74.0	56.7	42.2	36.4	30.0	25.3	49.1	36.6
Durga (F_1)	5.8	6.2	6.2	6.3	4.7	5.8	67.0	65.4	56.0	47.3	78.0	62.8	41.0	32.0	30.3	24.1	46.2	34.7
Raj Vendi(F_1)	5.6	5.8	6.3	6.5	4.8	5.8	61.7	57.0	57.0	44.0	83.2	60.6	44.0	37.0	32.3	29.4	51.0	38.7
Mayna(F_1)	4.2	4.6	4.8	5.5	4.1	4.6	84.0	72.2	66.0	51.5	93.0	73.3	46.2	39.1	36.0	32.0	54.0	41.5
Shakti (F_1)	5.7	5.9	6.2	6.4	4.8	5.8	67.2	61.4	62.0	56.0	74.0	64.1	41.3	36.2	31.6	28.0	48.2	37.1
Suhani (OP)	5.6	6.1	6.1	6.5	4.7	5.8	77.0	71.0	67.0	57.0	82.4	70.9	38.1	34.0	30.1	25.4	45.0	34.5
Novo-62(OP)	5.8	5.9	6.2	6.6	4.9	5.9	67.3	47.0	48.6	58.7	81.0	60.5	42.2	37.0	34.0	23.4	50.5	37.4
Vaner (OP)	5.9	6.4	6.7	7.3	5.3	6.3	57.0	55.4	46.0	41.0	67.5	53.4	41.0	36.2	30.0	27.0	48.0	36.4
Jhar-Pankaj (OP)	6.6	6.8	7.3	7.9	5.5	6.8	72.0	58.7	55.0	37.8	72.6	59.2	34.2	29.0	27.3	22.4	38.4	30.3
Satdhari (OP)	6.9	6.9	7.5	7.8	5.6	6.9	51.3	48.0	36.0	26.0	58.7	44.0	34.2	31.2	27.4	23.3	36.6	30.5
Sartaj (F_1)	5.8	6.2	6.4	6.6	5.1	6.0	68.0	66.0	55.0	42.3	74.3	61.1	37.2	34.2	26.6	22.4	46.0	33.3
Calyx-303 (OP)	5.9	6.7	6.6	6.9	5.2	6.3	74.0	67.3	67.0	40	76.3	66.1	35.2	32.0	26.2	21.0	47.2	32.3
Adharsa Jhar (OP)	5.8	6.3	6.3	6.5	4.9	6.0	73.0	68.3	61.0	47.5	75.3	65.0	34.0	33.1	28.0	23.0	44.2	32.5
Super Green (OP)	5.9	6.2	6.5	6.6	4.8	6.0	69.0	62.6	47.0	35.8	63.3	55.5	41.0	37.0	34.2	30.7	46.0	37.8
Mean	5.7	6.1	6.5	6.8	4.8	6.00	70.5	61.9	55.4	46.4	78.3	62.5	40.8	35.4	31.5	27.4	47.9	36.6
	CD (T)		0.02				CD (T)		0.23				CD (T)		0.07			
	CD (V)		0.08				CD (V)		1.14				CD (V)		0.35			
	CD (T×V)		0.41				CD(T×V)		11.14				CD (T×V)		3.03			

T_1- 50 mM NaCl, T_2-100 mM NaCl, T_3- 150 mM NaCl, T_4-200 mM NaCl, T_5- Control

Table 4: Performance of 25 okra genotypes on internodal length, node number at which first female flower appeared, and number of leaves per plant under different salinity levels

Variety/Hybrid	Internodal length (cm)						Node number at which first female flower appeared						Number of leaves per plant					
	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean
Shivani (F_1)	6.1	5.5	4.2	4.0	6.6	5.3	6.1	6.0	5.3	4.8	6.3	5.7	15.0	13.4	11.3	10.0	16.0	13.1
Samrat (F_1)	5.0	5.0	4.2	3.4	5.5	4.6	6.5	6.3	6.0	5.7	7.0	6.3	12.3	12.1	10.4	9.5	14.3	11.7
Japani Jhar (OP)	4.3	3.6	3.1	2.8	5.0	3.8	7.0	6.2	6.1	5.8	8.3	6.7	14.3	12.0	11.5	10.6	16.1	12.9
Rohini (F_1)	3.7	3.3	3.0	2.6	4.1	3.3	6.1	5.0	4.3	4.2	6.5	5.2	11.5	11.3	10.0	9.6	14.2	11.3
Gunjan(F_1)	4.2	4.1	3.7	3.1	4.5	3.9	8.1	7.4	7.2	6.9	8.2	7.6	13.2	12.0	11.5	10.0	15.4	12.4
Raj-333 (F_1)	3.8	3.5	3.3	3.2	4.3	3.6	8.1	8.0	7.2	6.8	8.1	7.6	13.4	12.5	12.2	10.2	14.0	12.5
Divya-192 (F_1)	5.0	4.3	3.4	3.1	5.1	4.2	5.5	5.3	5.1	5.0	6.3	5.4	12.3	11.4	11.2	10.0	13.6	11.7
Arka Ankita(F_1)	3.5	3.4	3.2	2.9	4.2	3.4	5.3	5.2	5.1	5.0	6.4	5.4	11.8	11.7	10.5	9.4	13.7	11.4
Arka Anamika (OP)	4.4	4.3	4.1	3.7	4.6	4.2	7.3	6.4	6.3	6.1	7.5	6.7	15.0	12.3	12.1	11.3	17.4	13.6
Jhimli (F_1)	4.0	3.3	2.9	2.5	4.3	3.4	6.7	6.3	6.1	5.9	7.3	6.5	12.4	12.2	11.3	11.2	14.0	12.2
Hybrid-302 (F_1)	4.1	3.6	3.5	3.2	4.4	3.8	7.5	7.3	7.0	6.7	8.0	7.3	13.2	11.3	10.5	10.2	15.4	12.1
Special Hariyali(F_1)	3.1	2.9	2.8	2.5	3.8	3.0	7.8	7.4	7.1	6.9	8.2	7.5	14.0	13.3	13.0	12.4	16.1	13.8
Durga (F_1)	3.6	3.5	3.1	2.9	4.3	3.5	8.0	7.7	7.4	7.1	8.4	7.7	12.0	11.3	10.0	9.2	13.4	11.2
Raj Vendi(F_1)	4.3	3.7	3.6	3.5	4.5	3.9	7.0	6.3	6.1	5.8	7.2	6.5	15.6	12.4	11.4	11.0	17.2	13.5
Mayna(F_1)	6.2	6.0	3.8	3.5	7.0	5.3	7.3	6.8	6.5	6.4	8.0	7.0	16.2	14.0	12.1	11.2	17.5	14.2
Shakti (F_1)	4.3	4.2	4.2	3.6	5.1	4.3	6.1	5.4	5.2	5.1	6.3	5.6	11.4	11.2	9.3	9	13.5	10.9
Suhani (OP)	4.1	4.1	4.0	3.8	4.3	4.1	5.4	5.1	5.0	5.0	7.0	5.5	14.4	11.3	10.0	9.5	15.5	12.2
Novo-62 (OP)	4.2	4.0	3.6	3.1	5.2	4.0	7.0	6.4	6.1	5.8	7.3	6.5	12.3	10.1	9.3	9.0	12.6	10.7
Vaner (OP)	3.7	3.5	3.3	3.0	4.1	3.5	7.3	6.0	5.7	5.6	8.0	6.5	10.2	10.3	9.2	9.1	12.4	10.2
Jhar-Pankaj (OP)	3.5	3.1	2.8	2.6	3.7	3.1	8.3	8.1	7.6	7.4	8.7	8.0	11.5	11.2	10.3	10.0	13.4	11.3
Satdhari (OP)	3.5	3.2	3.0	3.0	3.6	3.3	8.4	8.2	7.9	7.5	8.8	8.2	11.4	10.2	9.9	9.6	12.9	10.8
Sartaj (F_1)	2.9	2.9	2.5	2.1	3.8	2.8	8.3	8.2	7.2	7.0	8.4	7.8	12.0	11.3	10.5	9.2	14.2	11.4
Calyx-303 (OP)	4.2	3.6	3.1	2.5	5.1	3.7	7.4	7.0	6.7	6.5	9.0	7.3	12.4	10.0	9.2	8.3	14.0	10.8
Adharsa Jhar (OP)	3.1	3.0	2.8	2.7	3.5	3.0	7.2	6.7	5.1	5.1	8.4	6.5	13.0	12.7	11.6	10.0	15.3	12.5
Super Green (OP)	3.2	2.8	2.9	2.4	3.3	2.9	7.3	7.0	6.7	6.4	8.6	7.2	12.3	11.6	11.3	9.1	12.5	11.4
Mean	4.1	3.8	3.4	3.0	4.6	3.78	7.1	6.6	6.2	6.0	7.7	6.72	12.9	11.7	10.8	9.9	14.6	11.98
	CD (T)		0.02				CD (T)		0.02				CD (T)		0.03			
	CD (V)		0.09				CD (V)		0.09				CD (V)		0.16			
	CD (T×V)		0.66				CD (T×V)		0.60				CD (T×V)		1.27			

Table 5: Performance of 25 okra genotypes on leaf length, days to 50% flowering and days to attain edible fruit maturity under different salinity levels

Variety/Hybrid	Leaf length (cm)						Days to 50% flowering						Days to attain edible fruit maturity					
	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean
Shivani (F_1)	12.7	12.4	11.7	11.4	12.8	12.2	38.4	40.0	41.3	43.2	38.1	40.2	41.3	42.0	43.1	45.7	40.2	42.5
Samrat (F_1)	12.6	11.4	10.2	10.1	13.7	11.6	40.0	41.0	43.6	44.6	39.0	41.6	42.0	44.2	45.0	47.0	41.5	43.9
Japani Jhar (OP)	14.2	13.4	12.7	11.9	14.7	13.4	37.7	38.0	39.3	41.3	37.2	38.7	40.0	41.6	43.7	46.0	39.5	42.2
Rohini (F_1)	10.7	10.3	9.9	9.4	11.7	10.4	38.3	38.6	41.0	44	37.2	39.8	41.4	42.8	44.0	45.6	39.0	42.6
Gunjan(F_1)	11.5	10.3	10.2	9.5	12.0	10.7	38.0	39.0	42.3	44.2	35.2	39.7	40.1	41.0	44.6	45.0	38.0	41.7
Raj-333 (F_1)	12.4	11.4	11.0	10.9	14.5	12.1	42.1	43.3	44.0	46.6	40.7	43.3	44.0	45.5	46.0	48.3	42.0	45.2
Divya-192 (F_1)	12.0	11.6	10.6	10.3	13.1	11.5	42.0	44.2	45.3	47.1	41.0	43.9	45.2	46.9	48.3	50.0	43.1	46.7
Arka Ankita(F_1)	11.4	10.5	10.2	9.3	13.4	11.0	41.1	41.3	43.4	46.0	39.3	42.2	43.1	44.0	45.5	48.9	41.0	44.5
Arka Anamika (OP)	12.5	11.4	10.8	10.1	13.5	11.7	40.3	40.9	41.9	43.3	37.6	40.8	40.5	41.6	41.8	45.1	38.2	41.5
Jhimli (F_1)	10.6	10.4	9.3	8.9	11.8	10.2	41.2	43.0	44.0	47.3	39.6	43.0	43.6	45.4	46.2	49.2	42.0	45.3
Hybrid-302 (F_1)	11.6	10.7	9.5	8.7	12.6	10.6	42.2	44.2	45.7	47.4	41.4	44.2	44.5	46.0	48.4	49.1	43.2	46.2
Special Hariyali(F_1)	10.6	10.4	9.3	8.7	11.2	10.1	43.1	45.2	46.6	48.4	41.0	44.9	45.0	46.2	48.0	49.0	43.0	46.2
Durga (F_1)	10.5	9.3	8.7	8.3	11.6	9.7	42.0	46.3	46.7	48.0	40.2	44.6	44.0	47.3	48.5	51.4	42.1	46.7
Raj Vendi(F_1)	12.7	12.1	11.2	9.4	13.2	11.7	41.0	42.0	45.5	45.7	40.0	42.8	43.3	46.0	47.0	48.3	42.0	45.3
Mayna(F_1)	12.8	12.3	11.8	11.6	13.8	12.5	35.2	37.6	36.0	41.0	35.1	37.0	38.0	40.3	42.3	43.0	37.0	40.1
Shakti (F_1)	12.3	12.3	11.3	10.3	13.3	11.9	41.3	43.0	45.6	47.6	40.0	43.5	44.0	46.7	47.4	49.4	43.0	46.1
Suhani (OP)	12.6	12.5	11.9	11.5	14.7	12.7	40.0	41.2	42.7	44.1	38.0	41.2	43.5	44.0	45.3	46.0	40.2	43.8
Novo-62 (OP)	12.8	12.5	11.7	11.2	14.2	12.5	39.5	42.0	43.0	45.2	39.2	41.8	42.0	44.3	45.2	47.1	41.2	44.0
Vaner (OP)	11.7	9.9	9.8	8.9	12.9	10.6	43.0	45.3	47.2	49.0	42.0	45.3	46.9	48.0	50.5	52.0	45.0	48.5
Jhar-Pankaj (OP)	11.5	11.3	10.3	9.8	11.9	10.9	45.4	47.3	49.0	51.2	43.2	47.2	47.0	50.2	52.0	54.0	46.3	49.9
Satdhari (OP)	11.1	10.7	10.6	9.9	11.3	10.7	45.3	46.0	48.2	50.2	44.2	46.7	48.0	49.0	51.4	53.1	47.0	49.7
Sartaj (F_1)	11.2	10.7	10.3	9.1	12.7	10.8	42.0	43.4	44.3	45.0	41.0	43.2	44.5	45.3	47.0	48.0	43.4	45.6
Calyx-303 (OP)	10.5	10.6	9.9	9.7	11.4	10.4	40.4	42.5	41.2	44.2	40.2	41.7	43.1	45.0	46.4	48.2	42.0	44.9
Adharsa Jhar (OP)	11.1	10.7	9.7	8.6	11.5	10.3	40.0	42.0	44.0	45.1	39.3	42.1	43.0	45.4	47.0	48.0	41.0	44.9
Super Green (OP)	11.9	11.1	10.6	9.8	13.2	11.3	41.2	41.4	42.1	46.0	39.0	41.9	42.4	44.3	45.0	49.0	41.5	44.4
Mean	11.8	11.2	10.5	9.9	12.8	11.24	40.8	42.4	43.7	45.8	39.5	42.44	43.2	44.9	46.4	48.3	41.7	44.90
	CD (T)		0.03				CD (T)		0.05				CD (T)		0.04			
	CD (V)		0.14				CD (V)		0.24				CD (V)		0.22			
	CD (T×V)		0.79				CD (T×V)		1.48				CD (T×V)		1.17			

T_1- 50 mM NaCl, T_2-100 mM NaCl, T_3- 150 mM NaCl, T_4-200 mM NaCl, T_5- Control

Table 6: Performance of 25 okra genotypes on fruit length, fruit diameter and number of fruits per plant under different salinity levels

Variety/Hybrid	Fruit length (cm)						Fruit diameter (cm)						Number of fruits per plant					
	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean
Shivani (F_1)	10.6	10.2	10.1	9.1	13.2	10.6	5.2	5.1	5.1	4.8	5.9	5.2	11.2	9.3	8.1	7.3	13.4	9.9
Samrat (F1)	10.3	10.5	9.4	7.0	12.6	10.0	5.1	5.1	4.8	4.6	5.3	5.0	11.4	10.3	7.2	6.0	12.7	9.5
JapaniJhar (OP)	11.5	10.3	9.2	8.2	15.1	10.9	5.6	5.6	5.5	5.5	5.8	5.6	12.0	11.4	9.5	8.0	13.5	10.9
Rohini (F1)	9.7	8.3	7.1	6.4	12.8	8.9	5.5	4.9	4.6	4.5	5.6	5.0	10.4	9.1	7.0	6.0	11.3	8.8
Gunjan(F1)	12.3	12.6	10.5	9.4	14.6	11.9	5.5	5.3	4.9	4.7	5.6	5.2	13.5	12.4	10.7	9.8	15.4	12.4
Raj-333 (F1)	12.1	10.7	9.2	8.4	13.5	10.8	5.4	4.9	4.9	4.7	5.6	5.1	8.3	7.9	6.1	5.0	10.2	7.5
Divya-192 (F1)	12.7	10.2	9.3	8.6	13.3	10.8	5.5	5.3	4.9	4.5	5.6	5.2	10.7	8.0	6.5	5.2	11.2	8.3
ArkaAnkita(F1)	12.2	10.5	9.4	8.5	12.4	10.6	5.7	5.3	4.9	4.6	5.9	5.3	9.8	8.3	7.2	6.8	10.7	8.6
ArkaAnamika (OP)	12.4	10.6	9.2	8.8	13.7	10.9	5.4	5.3	4.8	4.1	5.6	5.1	12.5	11.3	9.1	8.1	13.4	10.9
Jhimli (F1)	13.2	10.3	9.6	7.4	15.1	11.1	5.1	4.9	4.7	4.5	6.2	5.1	8.3	7.1	5.1	4.2	9.7	6.9
Hybrid-302 (F1)	11.6	10.2	8.5	6.3	13.4	10.0	4.8	4.6	4.4	4.3	5.0	4.6	6.5	5.6	4.1	3.0	8.3	5.5
Special Hariyali(F1)	11.7	11.3	9.5	8.4	14.5	11.1	5.4	5.3	5.0	4.6	5.6	5.2	9.4	7.3	6.2	5.1	10.5	7.7
Durga (F1)	14.9	12.1	9.1	9.1	16.8	12.4	5.4	5.2	5.2	5.1	5.5	5.3	7.2	6.3	5.1	4.3	8.6	6.3
Raj Vendi(F1)	12.6	11.5	11.4	9.3	15.7	12.1	5.6	5.4	5.4	5.4	6.0	5.6	8.5	7.3	6.2	5.2	8.4	7.1
Mayna(F1)	13.2	13.4	11.5	10.6	16.6	13.1	5.0	5.0	4.7	4.4	5.4	4.9	14.3	13.4	11.5	10.2	16.2	13.1
Shakti (F1)	10.2	10.8	9.3	7.6	13.7	10.3	6	5.4	5.1	4.6	6.4	5.5	9.7	7.5	6.7	5.0	10.1	7.8
Suhani (OP)	11.7	9.8	9.9	8.1	13.2	10.5	5.2	4.7	4.4	4.2	5.3	4.8	11.1	10.0	9.0	8.0	12.1	10.0
Novo-62 (OP)	10.1	10.1	10.1	9.1	13.8	10.7	5.1	5.7	5.4	5.1	5.6	5.4	10.2	8.3	7.2	4.6	11.1	8.3
Vaner (OP)	10.5	10.2	8.3	8.4	14.3	10.3	5.3	5.2	5.0	4.8	5.7	5.2	7.3	6.6	5.1	3.2	8.3	6.1
Jhar-Pankaj (OP)	11.4	10.4	9.3	7.2	13.5	10.4	4.7	4.6	4.5	4.5	4.9	4.7	6.5	5.0	4.0	2.5	7.1	5.0
Satdhari (OP)	10.3	7.4	7.6	6.3	12.1	8.7	4.6	4.4	4.3	4.1	5.1	4.5	4.1	4.1	3.0	2.1	6.5	4.0
Sartaj (F1)	11.5	9.7	8.2	6.3	14.0	9.9	4.9	4.7	4.5	4.4	5.5	4.8	5.6	5.4	4.3	4.0	7.2	5.3
Calyx-303 (OP)	12.5	10.6	9.5	9.5	14.5	11.3	5.6	5.5	5.3	5.3	5.7	5.5	7.5	7.0	6.0	5.4	8.7	6.9
AdharsaJhar (OP)	10.8	10.7	9.8	9.3	13.3	10.8	4.7	4.0	4.4	4.4	4.9	4.5	8.5	7.3	7.2	5.1	9.4	7.5
Super Green (OP)	13.8	11.8	11.2	10.1	14.1	12.2	4.9	4.4	4.3	4.2	5.2	4.6	5.1	4.1	4.1	3.0	6.1	4.5
Mean	11.8	10.6	9.5	8.3	14.0	10.84	5.3	5.0	4.8	4.6	5.6	5.06	9.2	8.0	6.6	5.5	10.4	7.94
	CD (T)		0.03				CD (T)		0.02				CD (T)		0.03			
	CD (V)		0.17				CD (V)		0.08				CD (V)		0.14			
	CD (T×V)		1.39				CD (T×V)		0.40				CD (T×V)		1.06			

T_1- 50 mM NaCl, T_2-100 mM NaCl, T_3- 150 mM NaCl, T_4-200 mM NaCl, T_5-control

Table 7.Performance of 25 okra genotypes on fruit weight, 1000-seed weight and fruit yield per plant under different salinity levels

Variety/Hybrid	Fruit weight (g)						1000 seed weight (g)						Fruit yield per plant (g)					
	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean
Shivani (F_1)	16.1	17.1	13.5	12.1	23.1	16.4	41.2	39.0	37.2	36.7	42.0	39.2	158.3	125.6	74.8	75.9	269.6	140.8
Samrat (F_1)	13.7	12.2	10.3	9.3	14.5	12.0	43.4	41.6	40.4	39.0	45.4	42.0	156.2	142.5	74.3	55.9	184.2	122.6
Japani Jhar (OP)	18.3	14.1	14.5	12.1	22.5	16.3	49.4	47.5	47.2	46.8	51.3	48.5	168.8	91.0	101.7	72.4	258.3	138.4
Rohini (F_1)	14.2	10.1	8.3	8.7	20.1	12.3	55.0	54.2	52.4	52.2	56.0	54.0	147.2	245.7	58.1	52.2	227.6	146.1
Gunjan(F_1)	16.1	19.5	12.7	13.4	21.5	16.6	52.6	52.3	50.0	49.0	54.6	51.7	217.1	111.4	135.9	131.3	331.3	185.4
Raj-333 (F_1)	15.3	15.4	11.6	9.6	21.2	14.6	41.5	40.5	40.4	38.2	43.0	40.7	151.9	122.4	88.5	60.4	229.5	130.5
Divya-192 (F_1)	18.4	15.3	11.8	9.2	20.5	15.0	55.0	54.0	53.6	51.7	56.8	54.2	219.4	114.6	72.7	45.9	220.6	134.6
Arka Ankita(F_1)	16.5	13.8	11.2	10.6	19.8	14.4	51.6	51.2	49.5	48.0	53.3	50.7	162.3	150.3	81.3	72.1	213.2	135.9
Arka Anamika (OP)	16.3	18.7	16.5	13.6	21.1	17.2	50.0	49.0	48.0	46.4	52.4	49.2	231.3	79.0	105.9	99.3	295.2	162.1
Jhimli (F_1)	15.8	11.2	11.3	9.7	26.6	14.9	40.7	40.4	39.7	37.2	41.0	39.8	131.1	69.0	57.5	40.8	258.0	111.3
Hybrid-302 (F_1)	13.1	12.3	10.7	9.2	21.1	13.3	38.0	37.7	37.6	36.1	39.5	37.8	85.4	88.2	43.9	27.6	174.9	84.0
Special Hariyali(F_1)	19.5	12.1	7.9	8.3	24.4	14.4	54.5	54.3	52.0	49.0	56.6	53.3	183.4	85.7	48.9	42.3	256.2	123.3
Durga (F_1)	18.3	13.6	11.4	10.2	20.1	14.7	46.6	44.4	44.1	42.2	48.0	45.1	117.4	135.2	61.6	33.9	172.6	104.1
Raj Vendi(F_1)	18.5	13.3	11.2	12.2	22.0	15.4	36.7	35.0	34.6	34.5	37.3	35.6	138.6	269.9	102.0	70.2	176.8	151.5
Mayna(F_1)	22.0	20.1	16.1	14.5	26.3	19.8	41.0	40.5	38.0	37.5	42.3	39.9	315.0	121.1	184.6	146.7	425.5	238.6
Shakti (F_1)	14.3	11.2	9.2	10.4	20.1	13.1	46.5	45.0	44.1	42.0	48.3	45.2	155.9	141.3	90.5	57.5	233.0	135.6
Suhani (OP)	13.7	14.3	11.2	12.1	18.5	14.0	53.6	53.4	51.3	50.4	55.0	52.7	158.0	118.2	123.3	82.4	244.4	145.3
Novo-62 (OP)	14.2	14.1	13.1	11.5	20.2	14.6	51.4	50.0	48.3	47.4	53.4	50.1	165.7	81.2	101.5	46.0	292.4	137.4
Vaner (OP)	16.3	14.2	14.1	10.7	26.3	16.3	48.0	46.7	46.0	44.4	49.5	46.9	103.3	58.5	56.4	29.4	134.5	76.4
Jhar-Pankaj (OP)	14.2	12.3	11.1	11.0	16.2	12.9	39.2	38.0	37.4	35.0	40.0	37.9	93.0	60.9	41.2	18.2	124.3	67.5
Satdhari (OP)	14.3	11.7	10.3	9.6	17.5	12.7	43.2	42.6	42.4	40.2	46.6	43.0	62.7	73.9	34.8	21.0	141.1	66.7
Sartaj (F_1)	14.1	12.5	10.7	9.1	19.1	13.1	33.5	32.0	30.3	29.3	35.5	32.1	102.5	96.6	58.1	45.6	162.0	92.9
Calyx-303 (OP)	18.5	13.7	13.5	10.8	22.5	15.8	32.0	31.3	29.0	28.0	33.7	30.8	117.8	104.4	69.0	47.5	159.2	99.6
Adharsa Jhar (OP)	15.7	13.8	11.6	10.8	18.3	14.0	42.7	40.4	38.2	37.3	44.0	40.5	137.7	51.4	90.7	55.6	166.4	100.4
Super Green (OP)	16.2	14.3	12.6	9.8	17.7	14.1	40.0	39.0	38.0	36.7	43.8	39.5	78.6	54.3	45.4	30.3	101.3	62.0
Mean	16.1	14.0	11.9	10.7	20.8	14.70	45.1	44.0	42.8	41.4	46.8	44.02	150.3	111.7	80.1	58.4	218.1	123.72
	CD (T)		0.07				CD (T)		0.05				CD (T)		1.52			
	CD (V)		0.36				CD (V)		0.23				CD (V)		7.60			
	CD (T×V)		3.27				CD (T×V)		1.23				CD (T×V)		69.75			

T_1- 50 mM NaCl, T_2-100 mM NaCl, T_3- 150 mM NaCl, T_4-200 mM NaCl, T_5- Contro

and were of the opinion that saline conditions cause a substantial reduction in morphological features such as shoot length, fresh plant weight, and leaf area. Excessive entry of toxic ions into the plant inhibits radicle and plumule growth by disintegrating their tissues. Similar reports were voiced by Katerji *et al.,* 2012 who opined that growth parameters like seedling shoot length, seedling root length, seedling fresh weight and seedling dry weight exhibited a strong negative correlation with salinity. Further the growth attributes may be linked with the function of PGRs, stimulating the growth and development. The water potential gets reduced in the root zone with the increasing salinity level which lowers the cell turgidity and this in turn hampers the cell differentiation and cell elongation which leads to inhibition of growth in cultivars grown under saline condition. Salik *et al*. (2021) observed the reduction in fresh pod weight in okra with the increased level of salinity which may be due to the high soil salinity causing a reduction in cell division, cell elongation and injury of plant cells.

Table 8.Performance of 25 okra genotypes on Total phenol and chlorophyll content in fruit under different salinity levels

Variety/Hybrid	Total phenol content in fruit (mg GAE/g DW)						Total chlorophyll content in fruit (mg/100g)					
	T_1	T_2	T_3	T_4	T_5	Mean	T_1	T_2	T_3	T_4	T_5	Mean
Shivani (F_1)	2.3	2.4	2.4	4.3	1.4	2.6	0.5	0.4	0.4	0.3	0.6	0.4
Samrat (F_1)	2.1	2.1	2.2	4.1	1.3	2.4	0.4	0.4	0.4	0.3	0.4	0.4
JapaniJhar (OP)	1.4	1.8	1.9	2.4	1.2	1.7	0.5	0.5	0.4	0.4	0.6	0.5
Rohini (F_1)	1.4	1.7	3.2	5.1	0.6	2.4	0.5	0.5	0.4	0.3	0.5	0.4
Gunjan(F_1)	0.9	1.4	2.2	3.8	0.5	1.8	0.4	0.3	0.3	0.3	0.4	0.3
Raj-333 (F_1)	1.5	2.3	2.6	2.7	1.1	2.1	0.4	0.4	0.3	0.3	0.5	0.4
Divya-192 (F_1)	0.6	1.5	1.6	2.3	0.5	1.3	0.3	0.3	0.4	0.4	0.4	0.4
ArkaAnkita(F_1)	1.2	1.4	2.1	2.5	1.2	1.7	0.4	0.4	0.3	0.3	0.4	0.4
ArkaAnamika (OP)	1.0	1.3	3.2	6.4	0.5	2.5	0.5	0.4	0.4	0.4	0.6	0.5
Jhimli (F_1)	1.8	2.1	2.5	3.7	1.2	2.3	0.4	0.4	0.4	0.3	0.5	0.4
Hybrid-302 (F_1)	1.6	1.8	1.8	2.1	1.5	1.8	0.4	0.3	0.3	0.3	0.4	0.3
Special Hariyali(F_1)	1.7	1.8	1.9	2.5	1.2	1.8	0.4	0.3	0.3	0.3	0.4	0.3
Durga (F_1)	0.6	0.8	1.1	1.8	0.5	1.0	0.4	0.4	0.4	0.3	0.4	0.4
Raj Vendi(F_1)	1.1	1.2	1.7	2.6	0.7	1.5	0.5	0.4	0.4	0.3	0.5	0.4
Mayna(F_1)	1.2	1.4	2.1	2.5	1.2	1.7	0.6	0.5	0.5	0.5	0.7	0.6
Shakti (F_1)	1.7	1.9	2.9	2.9	1.1	2.1	0.4	0.4	0.4	0.3	0.5	0.4
Suhani (OP)	2.1	2.2	2.7	3.9	1.7	2.5	0.7	0.6	0.4	0.4	0.7	0.6
Novo-62 (OP)	1.0	1.2	1.3	1.7	0.8	1.2	0.8	0.7	0.6	0.5	0.9	0.7
Vaner (OP)	1.9	2.7	3.4	3.6	1.9	2.7	0.4	0.4	0.4	0.3	0.4	0.4
Jhar-Pankaj (OP)	2.7	3.4	3.7	4.1	2.7	3.3	0.4	0.4	0.3	0.3	0.5	0.4
Satdhari (OP)	1.3	1.6	1.9	2.0	1.2	1.6	0.5	0.4	0.3	0.3	0.5	0.4
Sartaj (F_1)	1.7	2.2	2.3	2.6	1.6	2.1	0.3	0.3	0.3	0.2	0.4	0.3
Calyx-303 (OP)	1.2	1.2	1.3	1.8	1.2	1.3	0.3	0.3	0.2	0.2	0.3	0.3
AdharsaJhar (OP)	1.0	1.1	1.1	1.2	0.9	1.1	0.4	0.3	0.3	0.3	0.4	0.3
Super Green (OP)	1.2	1.2	1.2	1.5	0.9	1.2	0.3	0.3	0.3	0.2	0.4	0.3
Mean	1.5	1.7	2.2	3.0	1.1	1.90	0.4	0.4	0.4	0.3	0.5	0.40
	CD (T)		0.02				CD (T)		0.00			
	CD (V)		0.12				CD (V)		0.01			
	CD (T×V)		1.05				CD (T×V)		0.07			

T_1- 50 mM NaCl, T_2-100 mM NaCl, T_3- 150 mM NaCl, T_4-200 mM NaCl, T_5- Control

Biochemical traits

Total chlorophyll content

Total chlorophyll content in fruit was found maximum in Mayna (F_1) under all the salinity levels followed by Gunjan (F_1) under 50 mM and100 mM NaCl, while under 150 mM, 200 mM and control Arka Anamika (OP) recorded the highest values (Table 8). Saleem *et* *al*. (2011) found data that were similar, showing that salt stress had no effect on chlorophyll a content but had a significant negative impact on chlorophyll b and overall chlorophyll. This can happen as a result of increased activity of the crucial enzyme chlorophylase, which breaks down chlorophyll, or because some crucial proteins involved in controlling chlorophyll in stressed plants leak out (Dubey 2005).

Total phenol content

The total phenol content gradually declined with increased salinity levels (Table 8) which agreed well with the observations of Bayat *et al*. (2022). It was highest in Mayna (F_1) under extreme salinity level followed by Gunjan (F_1). Reactive oxygen species (ROS) are produced in response to salt stress, which damages lipids, proteins, and nucleic acids (Foyer, 2018). Plant antioxidant activity rises as a result of the scavenging and detoxification of these chemicals from the cell surface by antioxidant defense systems in plants (Bayat and Moghadam, 2019).

CONCLUSION

It was discovered throughout the course of our experiment that two hybrids, Mayna and Gunjan, performed better under salinity stress in terms of growth, yield and biochemical characteristics.After thorough testing at the field level, both of these hybrids could be advised for large-scale production in saline-prone locations. However, Arka Anamika, Suhani, Japani Jhar, and Novo-62, promising OP cultivars, could be used as donor parents to create hybrids with high salinity tolerance.

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REFERENCE

Abbas, T., Pervez, M.A., Ayyub, C.M., Shaheen, M.R., Tahseen, S., Shahid, M.A., Bilal, R.M. and Manan, A. (2014) Evaluation of different okra genotypes for salt tolerance. *International Journal of Plant, Animal and Environmental Sciences* **4**(3): 23-30.

Abid, M., Malik, S.A., Bilal, K. and Wajid, R.A. (2002) Response of okra (*Abelmoschus esculentus* L.) to EC and SAR of irrigation water. *International Journal of Agriculture and Biology* **4**(3): 311–314.

Aron, D. (1949) Copper enzymes isolated chloroplasts, polyphenoloxidase in *Beta vulgaris*. Plant Physiology **24**: 1-15.

Bayat, H. and Moghadam, A.N. (2019) Drought effects on growth, water status, proline content and antioxidant system in three *Salvia nemorosa* L. cultivars. *Acta Physiologiae Plantarum* **41**(9): 149.

Bayat, H., Shafie, F. and Shahraki, B. (2022) Salinity effects on growth, chlorophyll content, total phenols, and antioxidant activity in *Salvia lavandulifolia* Vahl. *Advances in Horticultural Sciences* **36**(2): 145-153.

Dubey, R.S. (2005) Photosynthesis in plants under stress full conditions, In: Pessarakli, M.Ed. Photosynthesis, CRC Press, New York, pp. 717– 718.

Dudley, L.M., Ben-Gal, A. and Shani, U. (2008) Influence of plant, soil and water on the leaching fraction. *Vadose Zone Journal* **7**(2): 420–425.

Foyer, C.H. (2018) Reactive oxygen species, oxidative signaling and the regulation of photosynthesis. *Environmental and Experimental Botany* **154**: 134-142.

Foyer, C.H. and Noctor, G. (2003) Redox sensing and signalling associated with reactive oxygen in chloroplasts, peroxisomes and mitochondria. *Physiologia Plantarum* **119**(3): 355–364.

Katerji, N., Mastrorilli, M., Lahmer, F.Z. and Oweis, T. (2012) Emergence rate as a potential indicator of crop salt tolerance. *European Jour.l of Agronomy* **38**(1): 1-9.

Larcher, W. (1980) Physiological plant ecology, 2nd edition, Springer Berlin, Heidelberg, 303p.

Manchanda, G. and Garg, N. (2008) Salinity and its effects on the functional biology of legumes. *Acta Physiologiae Plantarum* **30**: 595–618.

Miller, G., Suzuki, N., Ciftci-Yilmaz, S. and Mittler, R. (2010) Reactive oxygen species homeostasis and signaling during drought and salinity stresses. *Plant, Cell & Environment* **33**: 453–467.

Minhas, P.S. and Gupta, R.K. (1993) Using high salinity and SAR waters for crop production– Some Indian experiences, In: Leith, H. and Al-Masoom (Eds.), Towards the Rational Use of High Salinity Tolerant Plants (Vol.2), Kluwer Academic Publishers, Amsterdam, the Netherlands, pp. 423-432.

Munns, R. and Tester, M. (2008) Mechanisms of salinity tolerance. *Annual Review of Plant Biology* **59**: 651-81.

Mushtaq, N.U., Saleem, S., Rasool, A., Shah, W.H., Hakeem, K.R. and Rehman, R.U. (2020) Salt stress threshold in millets: perspective on cultivation on marginal lands for biomass. Phyton **90**: 51.

Odunnaike, J.O. (2011) Effects of salinity and water stress on the growth performance of *Abelmoschus esculentus* (L.) Moench and (*Corchorus olitorius* L.), A dissertation submitted to the Department of Biological Sciences, College of Natural Sciences, University of Agriculture, Abeokuta, Nigeria.

Parihar, P., Singh, S., Singh, R., Singh, V.P. and Prasad, S.M. (2015) Effect of salinity stress on plants and its tolerance strategies: a review. *Environmental Science and Pollution Research* **22**: 4056–4075.

Prado, F.E., Gonzalez, J.A., Boero, C., Gallardo, M., Boero, C. and Kortsarz, A. (1995) Changes in soluble carbohydrates and invertase activity in *Chenopodium quinoa* developed for saline stress during germination. *Current Topics in Phytochemistry* **14**: 1-5.

Saleem, A., Ashraf, M. and Akram, N. (2011) Salt (NaCl)-induced modulation in some key physio-biochemical attributes in okra (*Abelmoschus esculentus* L.). *Journal of Agronomy and Crop Science* **197**: 202–213.

Salik, A.W., Coskun, Z. and Amini, M.Z. (2021) Study on okra ((*Abelmoschus esculentus* L.) response to salt stress environment under Kabul climatic conditions, Afghanistan. *Journal of Advanced Research in Natural and Applied Sciences* **7**(2): 295-303.

Shahid, M.A., Pervez, M.A., Balal, R.M., Ahmad, R., Ayyub, C.M., Abbas, T. and Akhtar, N. (2011) Salt stress effects on some morphological and physiological characteristics of okra (*Abelmoschus esculentus* L.). *Soil & Environment* **30**(1): 66–73.

Song, J., Jiachao, Z., Zhao, W., Xu, H., Wang, F., Xu, Y., Wang, L., and Tian, C. (2014) Effects of salinity and nitrate on production and germination of dimorphic seeds applied both through the mother plant and exogenously during germination in *Suaeda salsa*. *Plant Species Biology* **31**(1): 19-28.

Tindal, H.D. (1983) Vegetable in the tropics, Macmillan Education Limited, London, pp. 325- 328.

Wei, X., Chen, M., Xiao, J., Liu, Y., Yu, L., Zhang, H. and Wang, Y. (2010) Composition and bioactivity of tea flower polysaccharides obtained by different methods. *Carbohydrate Polymers* **79**(2): 418–422.

Younis, S.A., Shahatha, H.A., Hagop, P.G. and Al-Rawi, F.I. (1991) Effect of salinity on the viability of rice seeds, Plant Growth, Drought and Salinity in the Arab Region. *The Egyptian Botanical Society*, pp. 235-244.

Zehra, A., Gul, B., Ansari, R. and Khan, M.A. (2012) Role of calcium in alleviating effect of salinity on germination of *Phragmites karka* seeds. *South African Journal of Botany* **78**: 122-128.

Zhang, H., Irving, L.J., Tian, Y. and Zhou, D. (2012) Influence of salinity and temperature on seed germination rate and the hydrotime model parameters for the halophyte, *Chloris virgata*, and the glycophyte, *Digitaria sanguinalis*. *South African Journal of Botany* **78**: 203-210.