Plant Archives Volume 20 No. 2, 2020 pp. 6025-6033 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

ASSESSMENT OF EGGPLANT (*SOLANUM MELONGENA* L.) GENOTYPES FOR SALT TOLERANCE BASED ON GERMINATION AND PHYSIOLOGICAL MARKERS

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Abstract

Eggplant (*Solanum melongena* L.) is the richest sources of vitamin A and B, minerals, phosphorus, protein and possesses medicinal properties and grown in warm seasonal vegetable crop grown by the Indian farmers. Abiotic stress such as salinity of soil and water is a problem for its growth for the areas with low amount of rainfall and hot temperature thereby causes the yield loss. There is lack of information about the varieties and their responses to abiotic stress, due to which there is limited success reported to control their production loss. Hence, to identify the stable source, 30 accessions of eggplant (*Solanum melongena* L.) were screened. Among 30 genotypes the highest seed germination (90-100 %) was observed in two genotypes [IC354140 (GT25); IC 354562 (GT26)]. Therefore, for study the salt responsiveness of the eggplant genotypes (SRGs), these two genotypes of the eggplant were selected. During the 30 days old seedlings of GT26 and 26 were treated with the different salt concentrations (0, 25mM, 50mM, 75mM, 100mM, 125mM, 150mM) and it was observed that germination percentage under salt stress was drastically reduced (35%) in GT26 compared to GT25. The dry weight, growth and survival of the seedling plantlets, relative water content, membrane stability index, total chlorophyll, flavonoid contents were gradually decreased with increase in the salinity treatments from control to 75mM NaCl in both the SRGs. GT26 showed highly stressful effects on the seedling growth in 100mM NaCl application, whereas GT25 showed comparative better growth in same concentration. The results showed that although salt stress increased the sodium level in all the parts of seedling in both the SRGs (GT25 and GT26), however, the accumulation of Na^+ in leaves were significantly higher in GT26. GT25 genotype accumulated more Na+ in the root and stem parts of the seedling. The reverse response was observed with the potassium content. Salinity drastically decreased the K^+/Na^+ ratio in all the plant parts in the two selected genotypes. On the basis of low and best performance of both the genotypes under high salinity levels, we concluded high salt concentration (100mM) affect the germination of eggplant seeds, also retard the seedling growth in the early phases. GT26 genotype can considered as salt sensitive genotype (SSG), while GT 25 was found to be most tolerant genotype (STG) to salt stress among the all 30 genotypes.

Key words: salt stress, genotypes, accessions, physiological markers, germination.

Introduction

Eggplant or eggplant (*Solanum melongena* L.) belongs to family Solanaceae, is an important vegetable crop grown in India and all the parts of world (Frary *et al.,* 2007; Khapte *et al.,* 2012), warm season's vegetable cultivated by the Indian farmers. Eggplant fruits are the richest source of vitamin A and B, minerals, phosphorus and proteins (Gopalan *et al.,* 2007) have various medicinal properties and are good for patients suffering from diabetic. India is the second largest producer of Eggplant in the world consists of large number of the cultivars according to consumer preference based on fruit color, size and shape. In Punjab it is sown over 4896 hectares and produces 58709 tons annually that indicates that Punjab is the major eggplant producing state in India. A number of biotic and abiotic stresses such as drought, salinity, alkalinity and pathogens are responsible for the low the crop yield of eggplant crop in India.

Salinity had adverse effects on germination (Nerson and Paris, 1984; Akinci, 1999), growth development (Chartzoulakis, 1992; Mendlinger and Pasternak, 1992), fruit set (Meiri *et al.,* 1982; Hall, 1983) and yield (Gough and Hobson, 1990; Adams, 1991; Graifenberg *et al.,* 1996). Seed germination and early seedling growth are the most sensitive stages which are stressed by salinity

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in most of the crops including eggplant (de Suuza *et al.,* 2014; Natale *et al.,* 2010). Eggplant category is considered as moderately sensitive crop (Shahbaz *et al.,* 2012). More consideration to salinity stress is requisite for the agricultural production with the eggplant and its varieties. The determination of salt tolerance of different varieties of the eggplant at the germination and seedling stages was essential as it provided the prospect to make decisions to decrease the pressure of salinity on agriculturally important crops. If the salt tolerance level of eggplant varieties was identified, then it minimized the salt injury during the more sensitive stages like germination and seedling stages (Wu *et al.,* 2009). Salinity stress tolerance capacity of the plant at the early developmental stages may not be correlated with the tolerance at the later growth and developmental stages, as salinity tolerance power of the plant is a polygenic, developmental stage specific, genotype dependent trait. Due to all such complex nature of the plant system and lack of appropriate techniques for introgression slow progress and little success has been made to identify and develop salt tolerant varieties of the crop plants specially in case of the eggplant (Singh *et al.,* 2011). Hence to fulfill the food requirements of the geometrically rising human population, we have to focus on production of valuable vegetable crops under the currently exist adverse conditions. Keeping the importance of all these aspects in mind, the present study was designed to examine the performance of selected genotypes of egg plants (eggplant) under saline conditions at their early development stages.

Material and methods

Plant material

Thirty eggplant (*Solanum melongena* L.) genotypes were used as experimental material for the screening of salt tolerance at germination and early seedling growth stage during the year 2018-19. The seeds of all the genotypes were procured from the Germplasm Exchange Division, National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Pusa Campus, New Delhi (Table 1).

Germination experiments

Thirty healthy and similar sized seeds of each genotype were each put into petri dishes and each dish was a replication in the germination experiments. The seeds were washed with sterilized distilled water. These seeds were transferred to sterile petri dishes containing two layers of filter paper moistened with 10 ml of treatment solutions. The salinity levels of treatments were 0 (tap water/ control), 25, 50, 75, 100, 125 and 150 mM NaCl. Such test solutions were used for irrigation to impose stress in the different genotypes of egg plants. The control treatment was without sodium chloride. Seeds were allowed to germinate at 25±1°C in the dark and on 4th day of the experiment, germination percentage of all the genotypes was measured. Best genotypes were selected on the basis of germination percentage for seed ling experiment.

Seedling experiments

In the seedling experiments, seeds of the selected genotype were sown in a seedling pot size: 35×35×15 cm filled with a standard soil: farm manure (2:1) mixture. Plants were grown in the field of Gautam Buddha University, at mean air temperature of 30/25 ± 3°C (day/ night). The experimental design was a completely randomized block with three replications. The seedlings were watered with tap water up to the three-four leaf stages (30 days) and then were watered every 2 or 3 days for the next 30 days with solutions (50 ml per pot) of 0, 50, 100 and 150 mM NaCl, prepared in tap water. Seedlings were harvested and washed with distilled water on the 60th day (125 and 150 mM NaCl application showed stress effects on the growth of seedlings) and measured the growth and physiological characteristics. The samples i.e. seedling was dried at 80°C completely in hot air oven for 2 days till constant weights were obtained and then incubated in desiccators before measuring the dry weight. Sodium and potassium contents were measured in dried samples. Survival % was also measured at regular intervals of time after every 15 days after salinity treatment. The leaves samples for relative water content (RWC), membrane stability index (MSI) and chlorophyll contents were collected from the second fully expanded fresh leaf from the top during the growth stage. The leaf samples were brought to the laboratory in ice bouquet so that the loss of moisture can be minimized. All the observations were mean of three replications.

Relative water content (RWC)

Leaf relative water content (RWC) was estimated by recording the turgid weight of 0.5 g fresh leaf samples by keeping in water for 4 h, followed by drying in hot air oven till constant weight is achieved as per the method of (Weatherley *et al.*, 1950).

$$RWC = \frac{\text{Fresh wt.} - \text{Dry wt.}}{\text{Turgid wt.} - \text{Dry wt.}} \times 100$$

Membrane stability index (MSI)

Membrane stability index (MSI) was estimated as per (Sairam *et al.*, 1997). For the estimation of membrane stability index 100 mg leaf material, in two sets, is taken

Table 1: Details of the eggplant genotypes used for screening for salt tolerance

S. No	Accession Number	Genotype No.	Sources	Country	State
1	EC038474	GT1	Afghanistan through Indian Embassy	Afghanistan	—
2	EC169079	GT2	Marutane seed Co. Japan	Japan	—
3	EC305048	GT3	Brought by Shri T. A. Tomas NBPGR	Bangladesh	—
4	EC379244	GT4	Food & Agri. Organization of the United Nations, Seed Exchange and Information Center, Plant Production and Protection Division, Viale Delle Terme di Caracalla, Rome, Italy	Italy	—
5	EC384970	GT5	IRRI, P.O. BOX -933, Manila Philippines	Philippines	—
6	EC393239	GT6	S. Africa, brought by D. R. Mathura Rai, SR. Scientist, Div. of Evaluation, NBPGR, New Delhi-12	South Africa	—
7	IC089818	GT7	Unknown	India	Kerala
8	IC089890	GT8	Unknown	India	Andhra Pradesh
9	IC089923	GT9	Unknown	India	Andhra Pradesh
10	IC090144	GT10	Unknown	India	Assam
11	IC090160	GT11	Unknown	India	Assam
12	IC090785	GT12	Unknown	India	Himachal Pradesh
13	IC090905	GT13	Institute	India	Tamil Nadu
14	IC111013	GT14	Unknown	India	Assam
15	IC111033	GT15	Unknown	India	West Bengal
16	IC111415	GT16	Unknown	India	Kerala
17	IC111439	GT17	Unknown	India	Tamil Nadu
18	IC112741	GT18	Unknown	India	Maharashtra
19	IC144145	GT19	Farmer field	India	Delhi
20	IC261814	GT20	Unknown	India	Odisha
21	IC279555	GT21	Unknown	India	Uttarakhand
22	IC345747	GT22	Unknown	India	Assam
23	IC350885	GT23	Farmers house	India	Madhya Pradesh
24	IC354135	GT24	Farmers field	India	Punjab
25	IC354140	GT25	Farmers field	India	Punjab
26	IC 354562	GT26	Institute	India	Jharkhand
27	IC354672	GT27	Institute	India	Jharkhand
28	IC354707	GT28	Institute	India	Jharkhand
29	IC374852	GT29	Unknown	India	Others
30	IC383372	GT30	Farmers field	India	Madhya Pradesh

in test tubes containing 10 ml of double distilled water. One set is heated at 40°C for 30 min in a metabolic water bath and the electrical conductivity of the solution is recorded on a conductivity bridge (C_1). Second set is boiled at 100°C on a boiling water bath for 10 min and its conductivity is measured on a conductivity bridge (C_2). Membrane stability index (MSI) is calculated as:

$$MSI = \left[1 - \frac{(C_1)}{(C_2)}\right] \times 100$$

Chlorophyll and total flavonoid contents (TFC)

Chlorophyll content was determined using methods of (Arnon, 1949). The 60 days old leaves of harvested seedlings of both genotypes were randomly sampled from all treatments. In the laboratory 0.5 gm of the fresh leaf tissue was measured and cut into small pieces into specimen bottle. 10ml of 80% acetone was added and the set up kept in the dark for 3 hours for chlorophyll to be extracted by the acetone. Absorbance of the chlorophyll solution measured using a spectrophotometer at 645 and 663 nm to determine the content of chlorophyll a and b and the total chlorophyll of the leaf tissue. The respective chlorophyll content in milligram of chlorophyll per gram of leaf collected was calculated using the formula of Arnon, (1949) as follows:

$$\text{Chlorophyll a } (\text{mg g}^{-1}\text{ fwt.}) = \frac{[12.7(A663) - 2.69(A645)] \times V}{1000 \times W}$$

Table 2: Germination Percentage (GP) of all genotypes.

S. No.	Genotype Accession No.	Germination (%)
1	EC038474	0
2	EC169079	0
3	EC305048	20
4	EC379244	10
5	EC384970	0
6	EC393239	10
7	IC089818	0
8	IC089890	0
9	IC089923	10
10	IC090144	10
11	IC090160	10
12	IC090785	10
13	IC090905	0
14	IC111013	10
15	IC111033	10
16	IC111415	30
17	IC111439	10
18	IC112741	20
19	IC144145	20
20	IC261814	40
21	IC279555	10
22	IC345747	70
23	IC350885	60
24	IC354135	40
25	**IC354140**	**90**
26	**IC 354562**	**90**
27	IC354672	0
28	IC354707	30
29	IC374852	20
30	IC383372	40

$$\text{Chlorophyll b } (\text{mg g}^{-1}\text{ fwt.}) = \frac{[22.9\,(A645 - 4.68\,(A663)] \times V}{1000 \times W}$$

$$\text{Total Chlorophyll } (\text{mg g}^{-1}\text{ fwt.}) = \frac{[20.2\,(A645 + 8.02\,(A663)] \times V}{1000 \times W}$$

Where, A = Optical density at respective wave length (nm); V = Final volume of chlorophyll extract in 80% acetone; W = Fresh weight of the tissue extracted

Total Flavonoids Content

• Sample Preparation for TFC: The sample extract of leaf (500mg) was dissolved in 10 ml methanol (solvent) and stored at room temperature. After 24 h, infusions were filtered through Whatman No. 1 filter paper and residue was re-extracted with equal volume of solvents. After 48 h, the process was repeated. Combined supernatants were evaporated to dryness under vacuum at 40°C using hot plate. The obtained extracts were stored in a refrigerator at 4°C in an amber bottle for analysis.

Table 3: Rating scale of 30 eggplant genotypes.

Rating	Germination and growth incidence (%)	Accession Number-Genotype	Total no.
1	High (90-100 %)	IC354140-GT25	2
		IC 354562-GT26	
2	Moderately (60-89 %)	IC345747-GT22	2
		IC350885-GT23	
3	Susceptible (30-59 %)	IC111415-GT16	5
		IC261814-GT20	
		IC354135-GT24	
		IC354707-GT28	
		IC383372-GT30	
4	Highly Susceptible (0-30 %)	EC038474-GT1	21
		EC169079-GT-2	
		EC305048-GT3	
		EC379244-GT4	
		EC384970-GT5	
		EC393239-GT6	
		IC089818-GT7	
		IC089890-GT8	
		IC089923-GT9	
		IC090144-GT10	
		IC090160-GT11	
		IC090785-GT12	
		IC090905-GT13	
		IC111013-GT14	
		IC111033-GT15	
		IC111439-GT17	
		IC112741-GT18	
		IC144145-GT19	
		IC279555-GT21	
		IC354672-GT27	
		IC374852-GT29	

The aluminum chloride colorimetric method was used for the determination of the total flavonoid content of the samples (Marinova*et al.,* 2005; Chang *et al.,* 2002; Pourmorad *et al.,* 2006; Miliauskas *et al.,* 2004). For total flavonoid determination, rutin was used to make the standard calibration curve. Stock rutin solution was prepared by dissolving 1.0 mg rutin in 10 mL methanol, then the standard solutions of rutin (6.25, 12.5, 25, 50, 80 and 100µg/ml) were prepared by serial dilutions using methanol. An amount of 0.6 mL diluted standard rutin solution was separately mixed with 0.6 mL of 10% aluminum chloride. After mixing, the solution was incubated for 60 min at room temperature. The absorbance of the reaction mixtures was measured against blank at 415 nm wavelength with a UV/Visible Spectrophotometer (Thermo Scientific). The concentration of total flavonoid content in the test samples was calculated from the calibration plot (mg/ ml) and

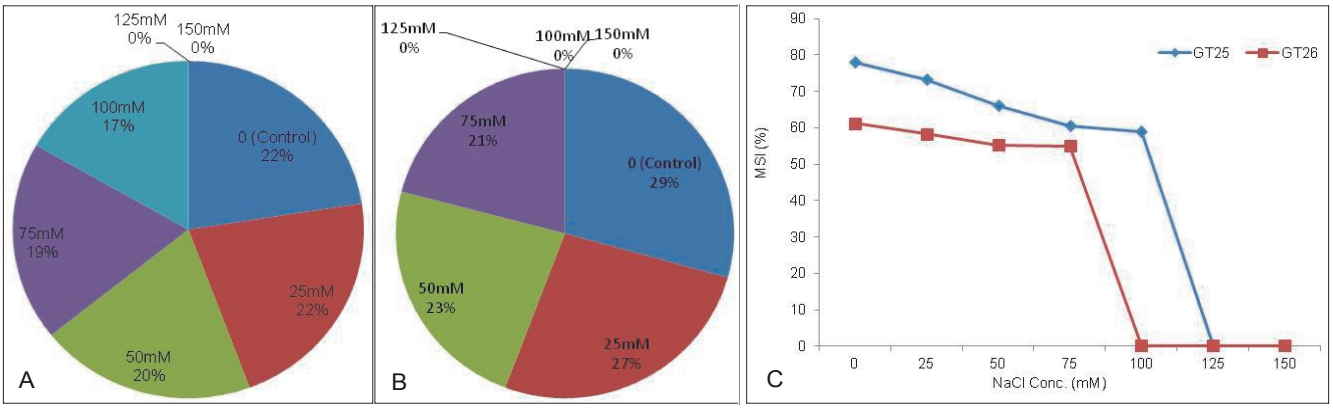

Fig. 1: (A) Effect of salinity levels on Relative water content (%) of seedling leaves in eggplant genotype (GT25); (B) Effect of salinity levels on Relative water content (%) of seedling leaves in eggplant genotype (GT26); (C) Membrane stability index (%) of seedling leaves in eggplant genotypes GT25 and 26 under salinity stress condition.

expressed as mg rutin (RU)/g of dried plant material. All the determinations were carried out in triplicate. To perform the calculations of total flavonoid content in the plant extract, a standard calibration curve is needed which is obtained from a series of different concentrations of a standard reference flavonoid (like Quercetin, Rutin, Naringenin). Total Flavonoid content had been evaluated as Quercetin equivalent (mg/g of dry extract or % per 100 g of dried herbs) when quercetin was used as standard flavonoid for comparison or Rutin equivalent (mg/ g of dry extract or % per 100 g of dried herbs) when Rutin used as standard flavonoid for comparison or Naringenin equivalent when Naringenin used as standard flavonoid for comparison.

Estimation of potassium and sodium Digestion of plant samples

The plant samples were dried in oven at 65±5°C and ground thoroughly. A representative ground plant sample (0.5 g) was taken for digestion. The samples were soaked overnight with 10ml of concentrated HNO_3 in conical flasks (100ml capacity) for pre-digestion and finally digested in a di-acid mixture (20ml) containing HNO_3 and $HClO_4$ acid (9:4). Keep the acid digested mixture on hot plate in acid proof digestion chamber at 100°C for 1 hour and then at 200°C to continue digestion till the appearance of white colorless fumes. Remove the flasks from hot plate, cool and add 30 ml DDW and filtered through whatman no.42 filter paper. The volume was made up to 25 ml and stored in a polypropylene container (100ml capacity) for further analysis.

Estimation of potassium, sodium and their respective ratio (K^+/Na^+)

The K and Na content in the standard solutions and plant samples (root, stem and leaf) were estimated by using K and Na - specific filters in a flame photometer (Systronics 128). By plotting a standard curve with known concentration of K and Na, the content of K and Na were calculated in different plant parts. The K/Na ratio was calculated in all the plant samples by dividing their respective individual values.

Plant Growth and Physiological Parameters

After 30 days of stress, seedling plantlets (total 60

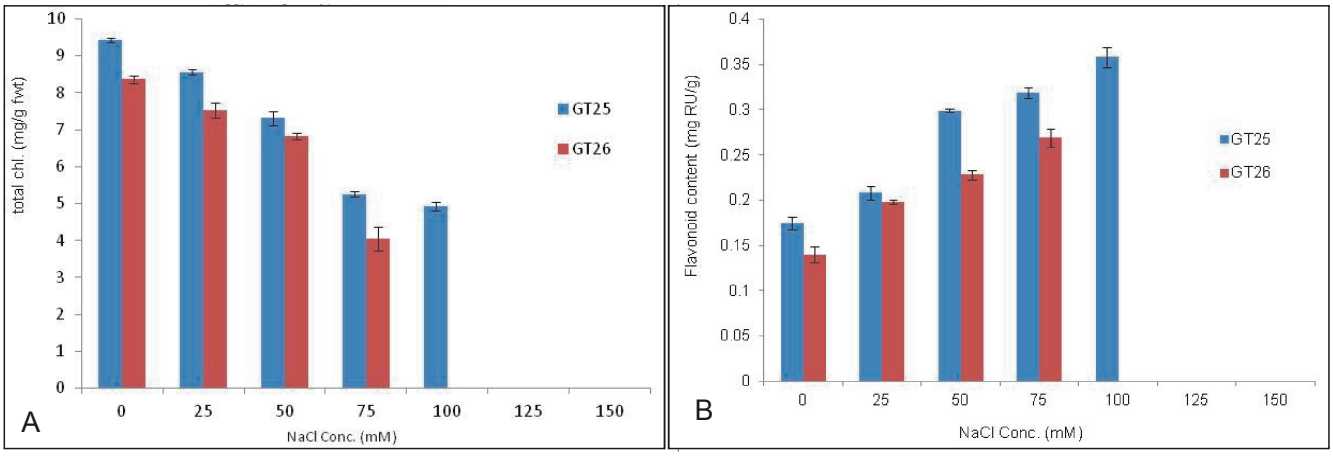

Fig. 2: (A) Effect of salinity levels on total chlorophyll content (mg/g fwt.) of seedling leaves of eggplant genotypes GT25 and 26; (B) Effect of salinity levels on flavonoid content (mg RU/g) of seedling leaves of eggplant genotypes GT25 and 26.

days old) were collected for the analysis of growth and physiological parameters. The fresh plant leaves were sampled after 60 days of transplanting for the determination of physio-biochemical attributes like RWC, MSI, Chlorophyll and flavonoids contents. 125 mM and 150 mM NaCl application of test solution showed stressful effects on the growth of seedlings.

Statistical analysis

Experimental design was completely randomized design with three replications and the data obtained was subjected to analysis of variance (ANNOVA) to

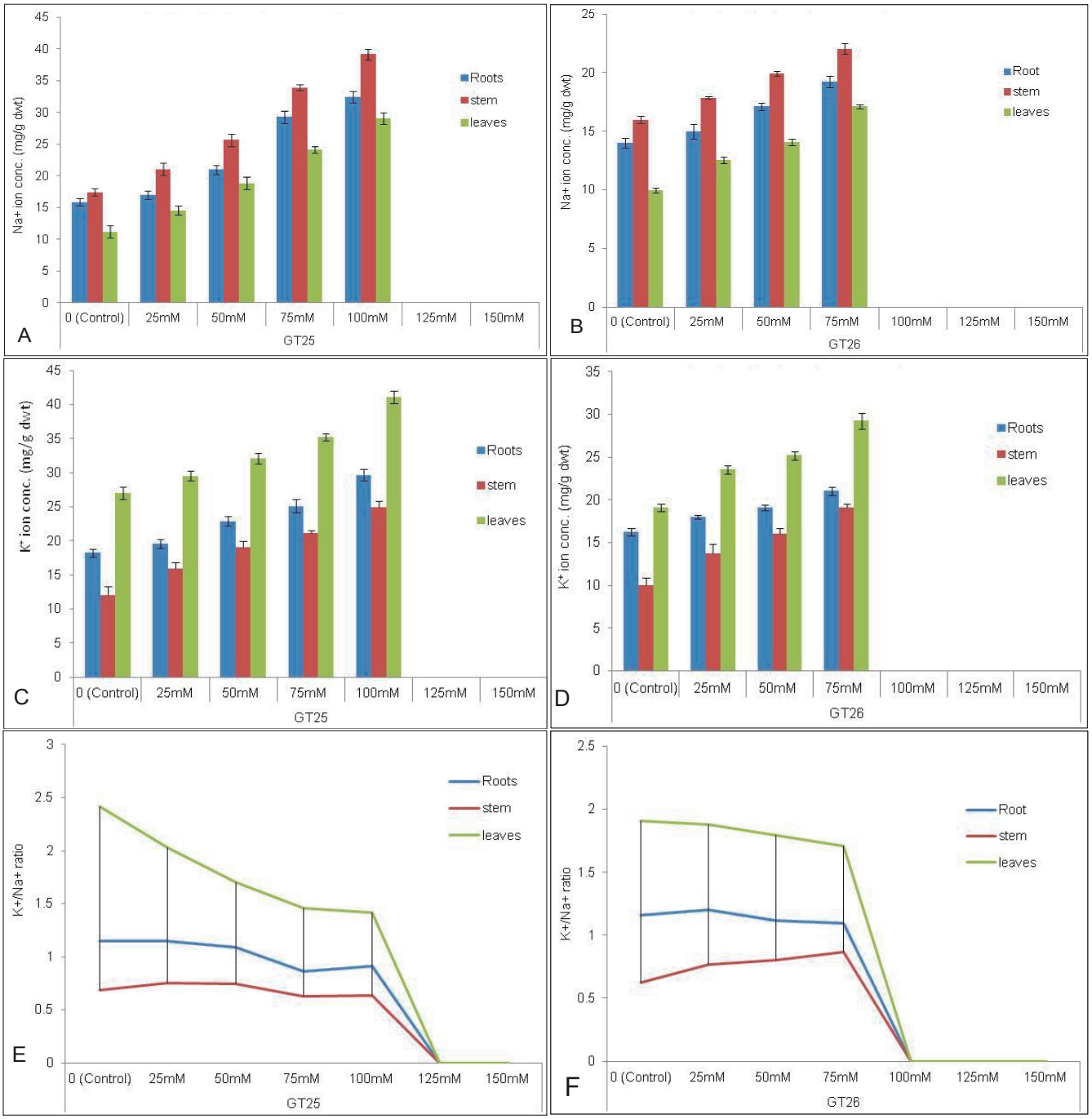

Fig. 3: (A) Na^+ ion concentration (mg/g dwt.) in roots, stem and leaves of eggplant seedling of genotype (GT25) under salinity stress condition; (B) Na^+ ion concentration (mg/g dwt.) in roots, stem and leaves of eggplant seedling of genotype (GT26) under salinity stress condition; (C) K^+ ion concentration (mg/g dwt.) in roots, stem and leaves of eggplant seedling of genotype (GT25) under salinity stress condition; (D) K^+ ion concentration (mg/g dwt.) in roots, stem and leaves of eggplant seedling of genotype (GT26) under salinity stress condition; (E) K^+/Na^+ ion ratio in roots, stem and leaves of eggplant seedling of genotype (GT25) under salinity stress condition; (F) K^+/Na^+ ion ratio in roots, stem and leaves of eggplant seedling of genotype (GT26) under salinity stress condition.

Table 4: Germination Percentage (GP) of genotypes 25 and 26 under different salt treatment.

Genotypes	Germination percentage						
	Salt concentration (NaCl mM)						
	0 (control)	25 mM	50 mM	75 mM	100 mM	125 mM	150 mM
GT25	90	85	70	55	40	No germination	No germination
GT26	90	70	45	35	No germination	No germination	No germination

determine the significance of differences among the treatments and genotypes.

Results

The results of germination percentage are presented in table 2. In our study we observed that the highest seed germination (90-100%) was observed in two genotypes [IC354140 (GT25); IC 354562 (GT26)], while the lowest percentage of seed germination (0-30%) noted in 21 types of genotypes. On the basis of our results we classified the selected 30 genotypes into four groups, as high, moderate [IC345747 (GT22)-IC350885 (GT23)]; susceptible [IC111415 (GT16)- IC261814 (GT20)-IC354135 (GT24)- IC354707 (GT28)- IC383372 (GT30)] and highly susceptible genotypes (Table 3). Genotypes GT-25 and GT-26 showed the greatest germination percentage**,** therefore to study the salt responsiveness of eggplant genotypes (SRGs), we have selected these two genotypes of eggplant for further study. Germinated seedlings (30 day old) of both SRGs were screen at different concentrations (0, 25mM, 50mM, 75mM, 100mM, 125mM, 150mM) of NaCl and observation was taken after 60th days of treatment. Germination percentage under salt stress was drastically reduced (35%) in GT26 compared to GT25 (Table 4). The dry weight, growth and survival of the seedling plantlets, relative water content, membrane stability index, total chlorophyll, flavonoid contents were gradually decreased

Fig. 4: Performance of tolerant (A) and susceptible (B) genotypes of eggplant under salinity stress; Duration of field experiment: October, 2018 to March, 2019.

with increase in salinity treatments from control to 75mM NaCl in both the SRGs (Fig. 1 and Fig. 2) GT26 showed highly stressful effects on the seedling growth in 100mM NaCl application, whereas GT25 showed comparative better growth in same concentration. GT25 showed less reduction in RWC, MSI, total chlorophyll and flavonoid contents, seedling growth length, survival and K^+/Na^+ ratio under high salinity level (100mM NaCl). The results showed that although salt stress increased the sodium level in all the parts of seedling in both the SRGs (i.e. GT25 and GT26), however, the accumulation of Na^+ in leaves were significantly higher in GT26. Interestingly, GT25 genotype accumulated more Na^+ in the root and stem parts of the seedling and thus allowing lesser amount of sodium in leaves. The reverse response was observed for the potassium content. Salinity drastically decreased the K^+/Na^+ ratio in all the plant parts in all the genotypes (Fig. 3). However, the K^+/Na^+ ratio was significantly higher in the leaves of GT25 genotype under salt stress than the GT26. On the basis of low and best performance of both the genotypes under high salinity levels, they were grouped as salt tolerant (high performance) and salt sensitive (low performance) genotypes (Fig. 4). On the basis of our obtained results we concluded that GT26 genotype showed low performance in each parameter can considered as salt sensitive genotype (SSG), while GT25 genotypes showed high value of all the studies parameters can considered as salt tolerant genotype (STG) of eggplant.

Discussion

High salt concentration in the roots reduces the soil water potential resulted the reduction of the relative water content. It creates osmotic stress condition in plants, which caused dehydration of plant cellular organelles. High salt concentration in the plant cell also effect the stability of the membrane. It caused membrane disorganization due to the leakage of salts/ ions; finally it decreased the stability of membrane. The results obtained in our finding support with the earlier reports of (Misra *et al.,* 2004; Chakraborty *et al.,* 2012). Salinity stress caused swelling of membranes in chloroplasts of sensitive plants which affects their chlorophyll content (Stogonov *et al.,* 1962). Therefore, the greater magnitude of these contents obtained in tolerant genotypes is responsible for their more

resistance than the sensitive genotypes. This corroborates with the earlier reports (Wahid *et al.,* 2004; Arulbalachandran *et al.,* 2009). Substantial differences for salinity induced stunted plant growth were observed among the genotypes where shoot growth was far more affected than the root. Distraction of energy from growth to maintenance under salt stress caused growth retardation (Greenway*et al.,* 2003). The result showed more decline in root and shoot dry weights in susceptible genotypes under salt stress over control. The results corroborate with the findings of (Saha *et al.,* 2010 and Yupsains *et al.,* 2001). Salinity changed water uptake capacity ultimately it altered ionic homeostasis balance in the plant. It also decreased the xylem exudation rate, leaf water potential, relative water content and water retention capacity. Higher concentration of essential potassium ion in leaf tissue also contributes to the salt tolerance ability of plants (Ashraf *et al.,* 1990). Reduction in K^+ level was due to specific ion effect of Na^+ ion (Blumwald *et al.,* 2000). The K^+/Na^+ ratio was significantly higher in the leaves of tolerant genotypes under salt stress indicating their capacity to maintain favorable cellular environment for growth and other metabolic activities, which can be the basis of their tolerance towards soil salinity. The results are in accordance with the earlier reports (Parveen *et al.,* 2004; Yasar *et al.,* 2006; Abdel Haleem *et al.,* 2007). Further, the chlorophyll and flavonoid content can be used as indicators of plant health stress and nutritional deficiencies. Our findings may be helpful in the further studies to monitor the effect of changing micro-climate on pigments synthesis in eggplant in terms of temperature, water, carbon dioxide concentration and soil condition.

Conclusion

The present study concludes that the selected salt responsive genotypes (SRGs) (GT25 and 26) exhibited significant variations for adaptation towards salt stress. The control treatment showed clear differences in germination percentage among the 30 genotypes. The GT25 and 26 showed significant differences in their tolerance to salinity. Genotype 25 was found to be most tolerant to salt stress among the genotypes. High salt concentration (100mM) affect the germination of eggplant seeds, also retard the early phases growth of seedlings. Finally, it can be concluded that salinity stress significantly decreased all studied traits.

Acknowledgements

Authors gratefully acknowledge to the Head Dr. Pratibha Brahmi (Principal Scientist and officer-In-Charge) and Dr. Satish Kumar Yadav (Principal scientist), Germplasm Exchange Unit, ICAR-National Bureau of Plant Genetic Resources, Indian Council of Agricultural Research, Pusa Campus, New Delhi for providing the seed material and to the Head Dr. B.S. Diwedi (Principal Scientist) and Sh Goverdhan Gena and Ashok Kumar (Technical staff), Division of Soil science and Agriculture Chemistry, IARI, New Delhi for providing required facilities to carry out the research work.

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