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EFFECT OF SALT STRESS ON GERMINATION AND SEEDLING EMERGENCE OF OKRA GERMPLASM COLLECTED FROM GARO HILLS, MEGHALAYA INDIA

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ABSTRACT

Okra (*Abelmoschus esculentus* L.) is an annual herb and commercial vegetable crop belonging to the family *Malvaceae*. It is grown throughout the tropical and subtropical parts of the world. Though India is considered as the second largest producer of Okra production, but its cultivation is hampered in saline and Sodic soils as it is moderately sensitive to salinity. Among the different abiotic factor's salinity is one of the common factors that limits agriculture productivity in broad sense but vegetable science as particular. Germination and its determining parameters under salt stress is the important factor for most of the high vale seeded vegetable crops. The present investigation was carried out at Department of Horticulture, NEHU, Tura Campus, Meghalaya and in the departmental research field in completely randomized block design with two factors. Tura under West Garo Hills District, Meghalaya. The experimental material comprised of a total of 7 (G1 to G7) Indigenous germplasm lines of okra collected from different parts of Garo hills region of Meghalaya. The salt stress was imposed comprising of different salt concentrations (20 mili-molar,40 mili-molar,60 mili molar,80 mili molar,100 mili molar) along with distilled water as control. The observations were recorded at germination stage. It was found that with the increase in salinity concentration there was a significant reduction in the final germination percentage, relative germination rate, germination index, relative germination index, relative salt injury rate, vitality index, plumule length, plumule fresh weight and plumule dry weight. Based on the results of the present experiment it was concluded Genotypes G2, G7 and G5 show resistant to overall aspects, while G4 and G6 were tolerant and G1 and G3 were susceptible.

***Keywords*:** Okra, Salt stress, Germination, Salt injury, Distilled Water

Introduction

Okra (*Abelmoschus esculentus* L. Moench), commonly known as bhindi or lady's finger, belongs to the Malvaceae family. It is an amphidiploid species with 2n = 130 chromosomes and is generally considered native to Africa (Schippers, 2000), although Zeven and Zhukovsky (1975) suggested that it may have originated in the Hindustani centre, mainly within India. Owing to its hardy growth habit, rich dietary fibre, and a balanced composition of essential amino acids such as lysine and tryptophan, okra has been described as "a perfect villager's vegetable" (Gemede *et al*., 2014). The immature pods are nutritious, supplying vitamins A, C and B-complex, along with minerals like iron and calcium, as well as proteins (Benjawan *et al*., 2007). It also serves as an important energy source, with 100 g of fresh pods contributing roughly 2,000 calories. Soil salinity remains a major constraint to agricultural productivity, particularly in arid and semi-arid regions where low rainfall restricts the leaching of salts beyond the root zone (Quesada *et al*., 2000; Tester and Davenport, 2003). Inefficient water management practices are also a major cause of soil salinity. During evaporation, water is lost in its pure form, leaving behind dissolved salts and other compounds that accumulate in the soil (Carter, 1975). Salinity develops when salts such as sodium chloride, sodium carbonate, sodium sulphate, or various magnesium salts become concentrated in the root zone. Among these, sodium chloride and sodium sulphate either individually or in combination are usually the most prevalent.

Managing saline soils generally involves choosing tolerant crops, ensuring proper crop establishment, applying adequate leaching, improving drainage, and implementing appropriate reclamation techniques. It is also expected that breeding for salinity tolerance will become increasingly important in the coming years (Flowers and Yeo, 1995). Although extensive research has been conducted on plant responses to salt stress, information on salt tolerance mechanisms in okra remains limited.

In the Garo Hills region of Meghalaya, numerous landraces and indigenous germplasm of okra are available, yet very few scientific studies have been undertaken to characterize them. The present research aims to identify superior genotypes that can be used in okra crop improvement programmes. Access to such diverse genetic material is essential for successful breeding efforts not only within the state but also at the regional level. Considering these factors, the current experiment was designed to assess the effects of salt (NaCl) stress on seed germination and associated parameters in seven okra genotypes.

Material and Methods

The present experiment was carried out at Department of Horticulture, NEHU, Tura Campus, Meghalaya during 2023-24 to study the response of 7 okra cultivars, G1 collected from Mendi, North Garo Hills, G2- Bajengdoba, North Garo Hills, G3- Rongram, West Garo Hills, G4- Chengkompara, South West Garo Hills, G5- Chokpotgre,Chokpot, South Garo Hills, G6- Warimagre, Williamangar, East Garo Hills, G7- Chasatgre, Williamangar, East Garo Hills, Meghalaya respectively under fconcentrations of NaCl (T0- distilled water control, T2- 20 mili-molar, T3-40 mili-molar, T4-60 mili molar, T5-80 mili molar, T6-100 mili molar). The experiment was conducted in factorial completely randomized design with three replications and were subjected to analysis of variance at 5% level of significance. For 1 liter of Distilled Water to prepare 1 mili molar salt solution 0.05844 grams of NaCL is dissolved. With respect to this the concentration 20 mili molar , 40 milimolar, 60 milimolar, 80 mili molar and 100 mili molars respectively were made and applied to the seeds as . The germination tests were accomplished in petri plates that were sterilized by keeping in hot air oven at 180 °C for 30 minutes. Germination paper was cut to the required diameter and autoclaved. The lower side of the germination paper was provided with a thin layer of cotton and then placed in Petri dishes. The air-dried seeds were then placed equidistantly (6seeds/ Petri dish). 10mL of each solution of Salt was poured in each Petri dish. A control was prepared for each set by using distilled water. An emergence of radicle was considered as seed germination and the number of seeds germinated was counted daily up to 10 days.

Final germination percentage

Germination Percentage (G%) = (Number of seeds germinated)/ Number of seeds sown x100

Relative germination rate

Relative germination rate= (Germination in salt stress)/(Germination in distilled water) x 100

Germination Index

Germination index (GI) is an estimate of the time (in days) it takes a certain germination percentage to occur. Germination index (GI) = Σ germinated seeds in day t (1, 2 ,3.. 12)/Day t

Relative germination index (RGI)

Relative germination index (RGI) = GI in salt stress /GI in control x 100

Relative Salt injury rate

Relative Salt injury rate= (G % of control - germination% in salt concentration)/ G % of control

Vitality index (VI)

Vitality Index (VI) was calculated by using the modified formula of Abdul-Baki and Anderson (1973).

Vitality index (VI) = Germination index x seedling length

Plumule length

Length of the plumule was measured with the help of a thread from tip of the plumule to its distal end and then measured by scale.

Plumule fresh weight

The seed coat was carefully removed and the delicate part of the plumule is taken out and weighed in digital weighing balance.

Plumule dry weight

At the end of the experiment day the plumule were collected and dried in hot air oven for 80 Degree C for 48-72 hours till a constant weight was achieved and weighed on electronic balance.

Result and Discussion

Table 1: Effect of different concentration of salt stress in number of seed germinated of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	6.00	5.67	4.34	4.01	2.68	0.01	**5.68**
G2	6.00	5.68	4.34	3.68	3.34	1.68	**6.18**
G3	5.67	4.68	4.01	2.34	1.68	0.01	**4.60**
G4	5.34	4.68	3.01	2.68	1.68	0.01	**4.35**
G5	5.34	3.34	3.01	2.68	3.01	2.68	**5.01**
G6	6.00	4.67	3.34	3.01	1.34	0.01	**4.60**
G7	6.00	3.68	2.68	2.68	2.34	1.68	**4.76**
G Total	**5.76**	**4.63**	**3.53**	**3.01**	**2.30**	**0.87**	**35.17**

Amongst the genotypes as per (Table1), the maximum number of seeds germinated in genotype G2 (6.18) which was followed by G1 (5.68) while genotype G4 (4.35) recorded as the minimum number of seeds germinated. The values varied significantly in between different concentrations of NaCl where maximum (5.76) was recorded in T0 (control, 0 milli molar salt solution) and lowest (0.87) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations for number of seeds germinated was found to be significantly different. The maximum number of seeds germinated (6.00) was observed in G1T0, G2T0, G6T0 and G7T0 which was followed by G2T1 (5.68). Whereas genotypes G3T0 (5.67), G4T0 (5.34) and G5T0 (5.34) was found at par with G1T0 (6.00), G2T0 (6.00), G6T0 (6.00) and G7T0 (6.00). The result showed a decline in number of seeds germinated under increasing salt stress. The results were in accordance with Zanetti *et al.*, 2019; Ibrahim *et al.*, 2016; Qu *et al.*, 2008; Hammami *et al.*, 2018).

Table 2 : Effect of different concentration of salt stress in germination percentage (%) of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	100.00	94.50	72.40	66.84	44.62	0.18	**94.64**
G2	100.00	94.50	72.40	61.29	55.73	27.95	**102.97**
G3	94.50	77.90	66.84	39.07	27.95	0.18	**76.61**
G4	88.95	77.95	50.18	44.62	27.95	0.18	**72.46**
G5	89.01	55.73	50.18	44.62	50.18	44.62	**83.58**
G6	100.00	77.90	55.73	50.18	22.40	0.18	**76.60**
G7	100.00	61.29	44.62	44.62	39.07	27.95	**79.39**
G Total	**96.07**	**77.11**	**58.91**	**50.18**	**38.27**	**14.46**	**586.24**

From (Table 2) illustrated that low concentrations of neutral salt (NaCl) had almost minimal inhibitory effect on the germination percentage of genotype G1 and G2. However, with increasing salt concentration, the germination percentage significantly was reduced. Among the genotypes, the maximum germination percentage was noticed in genotype G2 (102.97%) which was followed by G1 (94.64%) while genotype G4 (72.46%) recorded the minimum number of seeds germinated. The values varied significantly in between different concentrations of NaCl where maximum (96.07%) was recorded in T0 (control, 0 milli molar salt solution) and lowest (14.46%) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations for germination percentage was found to be significantly different. The maximum germination percentage (100%) was observed in G1T0, G2T0, G6T0 and G7T0 which was followed by G3T0 (94.50), G1 T1 (94.50) and G2T1 (94.50). Whereas genotypes G3T0 (94.50%), G4T0 (88.95%) and G5T0 (89.01%) was found at par with G1T0 (100%), G2T0 (100%), G6T0 (100%) and G7T0 (100%). The result showed a decline in germination percentage under increasing salt stress. The higher the amount of salt concentration in this research completely inhibited the seed germination may be due to the salinity levels which might cause osmotic stress or ion toxicity to the genotypes taken during this experiment. The result found was in accordance to the research done by Zapata *et al.* (2004).

Table 3 : Effect of different concentration of salt stress in relative germination rate of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	-	94.50	72.39	66.83	44.61	0.17	**69.63**
G2	-	94.61	72.39	61.28	55.72	27.94	**77.99**
G3	-	82.35	71.24	42.36	29.05	0.17	**56.29**
G4	-	89.00	58.47	50.15	33.49	0.19	**57.82**
G5	-	63.43	57.87	50.12	56.78	50.12	**69.58**
G6	-	77.89	55.72	50.17	22.39	0.17	**51.58**
G7	-	61.28	44.61	44.61	39.06	27.94	**54.38**
G Total	-	**80.44**	**61.81**	**52.22**	**40.16**	**15.25**	**437.27**

The data presented in Table3 with respect to relative germination rate revealed that there was a significant difference among the genotypes evaluated for the trait. Under control condition there is no effect of relative germination rate hence value not found. Amongst the genotypes, the maximum relative germination rate was noticed in genotype G2 (77.99) which was followed by G1 (69.63) while genotype G6 (51.58) recorded the minimum relative germination rate. The values varied significantly in between different concentrations of NaCl where maximum (80.44) was recorded in T0 (control, 0 milli molar salt solution) and lowest (15.25) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations for relative germination rate was found to be significantly different. The maximum relative germination rate was observed in G2T1 (94.61) which was followed by G1T1 (94.50). Whereas genotypes G1T1 (94.50), G3T1 (82.35), G4T1 (89.00) and G6T1 (77.89) was found at par with G2T1 (94.61). The result showed a decline in relative germination rate under increasing salt stress. This result is in agreement to the earlier researches shown for a number of vegetables as cucumber (Jones *et al.*, 1989), lettuce (Nasri *et al.*, 2011) and beans (Jeannette *et al.*, 2002).

Table 4 : Effect of different concentration of salt stress in germination index of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	0.76	0.71	0.70	0.65	0.58	0.56	**0.99**
G2	0.72	0.68	0.68	0.66	0.67	0.56	**0.99**
G3	0.73	0.67	0.66	0.62	0.56	0.53	**0.94**
G4	0.77	0.68	0.63	0.59	0.55	0.53	**0.94**
G5	0.79	0.66	0.66	0.63	0.60	0.57	**0.98**
G6	0.82	0.79	0.67	0.65	0.57	0.54	**1.01**
G7	0.79	0.69	0.62	0.60	0.57	0.55	**0.95**
G Total	**0.77**	**0.70**	**0.66**	**0.63**	**0.58**	**0.55**	***6.79***

The data presented in Table 4 with respect to germination index revealed that there was a significant difference among the genotypes evaluated for the trait. Significant variations were observed among the genotypes with respect to the germination index. Increasing salt concentration decreased the germination index. Among the 7 genotypes germination index highest was in genotype G6 (1.01 %) and lowest was recorded in genotype G3 (0.94 %) and G4 (0.94 %) respectively. The values varied significantly in between different concentrations of NaCl where maximum (0.77%) was recorded in T0 (control, 0 milli molar salt solution) and lowest (0.55%) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations for germination index was found to be significantly different. The maximum germination index was observed in G6T0 (0.82%) which was followed by genotypes G5T0 (0.79%) and G7T0 (0.79%) respectively. Whereas genotypes G1T0 (0.76%), G4T0 (0.77%), G5T0 (0.79%) and G7T0 (0.79) was found at par with G6T0 (0.82%). Salt stress is one of the important tensions in reducing the growth and production of plants. Similar findings were made, salinity may affect the germination of seeds by the toxic effects of excess sodium and chloride ions and thereby reducing the germination percentage. It can affect many aspects of plant metabolism and growth, because this tension reduces germination rate and index and finally delays establishment of plantlets (Prisco *et al.*, 1972).

Table 5: Effect of different concentration of salt stress in relative germination index (%) okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	-	81.70	79.19	57.41	31.48	21.79	**67.89**
G2	-	80.03	82.54	71.31	77.17	28.18	**84.81**
G3	-	74.40	68.69	52.98	24.70	14.27	**58.76**
G4	-	57.47	57.49	44.96	34.09	23.17	**54.29**
G5	-	57.47	57.49	44.96	34.09	23.17	**54.29**
G6	-	93.66	52.80	48.75	20.55	12.07	**56.96**
G7	-	65.17	39.79	33.43	23.35	17.80	**44.89**
G Total	-	**72.84**	**62.57**	**50.54**	**35.06**	**20.06**	**421.89**

The data presented in Table 5 with respect to relative germination index revealed that there was a significant difference among the genotypes evaluated for the trait. The relative germination index of the okra genotypes depicted that it decreased significantly in response to salinity magnitude as maximum decrease in relative germination index was noted. Under control condition there is no effect of relative germination index hence value not found. Amongst the 7 genotypes, the maximum relative germination index was noticed in genotype G2 (84.81) which was followed by G1 (67.89) while genotype G7 (44.89) recorded the minimum relative germination index The values varied significantly in between different concentrations of NaCl where maximum (72.84) was recorded in T0 (control, 0 milli molar salt solution) and lowest (20.06) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations for relative germination index was found to be significantly different. The maximum relative germination index was observed in G6T1 (93.66) which was followed by G2T2 (82.54) and minimum relative germination index was observed in case of genotype G6T5 (12.07). Whereas genotypes G1T1 (81.70), G2T1 (80.03), G3T1 (74.40) and G7T1 (65.17) was found at par with G6T1 (93.66). The result showed a decline in relative germination index under increasing salt stress. Increase in Na^{+} and Cl^{-} ion concentration induces ionic toxicity, oxidative stress and nutritional imbalance, ultimately leading to the inhibition of germination in many species. There were significant effects of salt concentrations on the relative Salt injury rate. As the concentration of salt increases the relative salt injury rate increase because the causes of salt are more and the injury is more.

Table 6: Effect of different concentration of salt stress in relative salt injury rate of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	-	32.39	32.61	32.67	32.89	33.33	**40.97**
G2	-	32.39	32.61	32.72	32.78	33.05	**40.89**
G3	-	30.68	30.79	31.08	31.21	31.50	**38.81**
G4	-	28.76	29.06	29.15	29.31	29.65	**36.48**
G5	-	29.03	29.09	29.17	29.10	29.17	**36.39**
G6	-	32.55	32.78	32.83	33.11	33.33	**41.15**
G7	-	32.72	32.89	32.94	32.94	33.05	**41.14**
G Total	-	**31.22**	**31.40**	**31.51**	**31.62**	**31.87**	**275.83**

The data presented in Table 6 with respect to relative salt injury rate revealed that there was a significant difference among the genotypes evaluated for the trait. Under control condition there is no effect of relative salt injury rate since there's no salt stress and hence value not found. Amongst the genotypes, the maximum relative salt injury rate was noticed in genotype G6 (41.15) which was followed by genotypes G7 (41.14). While G5 (36.39) recorded the minimum relative salt injury rate. The values varied significantly in between different concentrations of NaCl where maximum (31.87) was recorded in T5 (100 milli molar solution of NaCl) and lowest (31.22) in T1 (20 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations for relative salt injury rate was found to be significantly different. The maximum relative salt injury rate was observed in G1T5 (33.33) and G6T5 (33.33) which was followed by G3T5 (33.05) and G7T5 (33.05) respectively. Whereas in genotypes G2T5 (33.05), G3T5 (31.50), G4T5 (29.65), G5T5 (29.17) and G7T5 (33.05) were found at par with G1T5 (33.33) and G6T5 (33.33). While G4T1 (28.76) was found lowest. Salinity had increasing effect on relative salt injury rate; therefore, a remarkable increase in injury rate was noted as higher the salt concentration higher is the injury rate. Increase in Na+

and Cl^- ion concentration induces ionic toxicity causing oxidative stress may be due to increase in salt stress the injury level has increased resulting in higher injury. There were significant effects of salt concentrations on the vitality index. As the concentration of salt increases the vitality index decreases.

Table 7 : Effect of different concentration of salt stress in vitality index (%) of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	1.28	0.94	0.86	0.79	0.61	0.51	**1.25**
G2	1.81	1.20	1.07	0.93	0.80	0.54	**1.59**
G3	1.03	1.18	1.01	0.62	0.56	0.51	**1.23**
G4	1.45	0.85	0.83	0.70	0.51	0.51	**1.21**
G5	1.37	1.18	0.90	0.88	0.68	0.55	**1.39**
G6	2.31	1.88	1.16	1.00	0.69	0.51	**1.89**
G7	1.80	1.29	0.95	0.81	0.78	0.67	**1.57**
G Total	**1.58**	**1.22**	**0.97**	**0.82**	**0.66**	**0.54**	**10.13**

The data presented in Table 7 with respect to vitality index revealed that there was a significant difference among the genotypes evaluated for the trait. Among the genotypes, the maximum vitality index was noticed in genotype G6 (1.89) which was followed by G2 (1.59) while genotype G4 (1.21) recorded the minimum vitality index. The values varied significantly in between different concentrations of NaCl where maximum (1.58) was recorded in T0 (control, 0 milli molar salt solution) and lowest (0.54) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations for number of seeds germinated was found to be significantly different. The maximum vitality index was observed in G6T0 (2.31) which was followed by G6T1 (1.88). Whereas G6T0 (2.31) and G7T0 (1.80) were found at par with G2T0 (1.81) and G7T1 (1.80). The result showed a gradual decline in vitality index under increasing salt stress. Salinity had reductive effect on vitality index; therefore, a remarkable decrease in vitality index was noted as higher the salt concentration lower is the vitality index. This may be due to High concentrations of sodium (Na^+) and chloride (Cl^-) in the soil can be toxic to plants. These ions can interfere with enzyme activity and cellular processes, leading to reduced growth and vitality index.

Table 8: Effect of different concentration of salt stress in plumule length (cm) of okra genotypes.

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	3.54	2.61	2.31	2.54	1.91	0.51	**3.36**
G2	6.44	4.44	3.64	3.28	2.28	1.14	**5.31**
G3	2.78	4.48	3.74	1.48	1.58	0.51	**3.64**
G4	3.84	2.74	2.58	1.98	0.51	0.51	**3.04**
G5	3.31	2.81	2.94	3.18	3.24	1.94	**4.36**
G6	6.21	5.24	4.51	4.38	3.31	0.51	**6.04**
G7	5.01	4.71	4.37	3.71	4.58	3.94	**6.58**
G Total	**4.45**	**3.86**	**3.44**	**2.93**	**2.49**	**1.30**	**32.32**

Regarding to the plumule length of okra genotypes as affected by salt stress data are present in Table 8 showed that each genotypes, increasing salt stress level led to progressively decrease in plumule length due to salt toxicity. Amongst the genotypes, the maximum plumule length was noticed in genotype G7 (6.58 cm) which was followed by G6 (6.04 cm) while genotype G4 (3.04 cm) recorded the minimum plumule length. The values varied significantly in between different concentrations of NaCl where maximum (4.45 cm) was recorded in T0 (control, 0 milli molar salt solution) and lowest (1.30 cm) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations plumule length was found to be significantly different. The maximum plumule length (5.24 cm) was observed in G6 T1 which was followed by G7 T0 (5.01 cm). Whereas in G6T0 (6.21 cm) and G7T0 (5.01 cm) were found at par with G2T0 (6.44 cm). The result showed a decline in plumule length under increasing salt stress. Plumule length gets reduced under saline condition. This may be due to the action of salt stress that can directly inhibit cell elongation and division, leading to shortening in growth and reduced overall plumule length. In mungbean, reduction was observed in different plant parameters under varying salinity levels. (Abbas *et al.*, 2015)

Table 9 : Effect of different concentration of salt stress in plumule fresh weight (mg) of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	337.51	332.78	285.58	246.78	229.21	0.51	**358.09**
G2	378.88	349.98	268.11	233.48	185.08	169.51	**396.26**
G3	299.78	242.48	217.28	211.58	166.08	0.51	**284.42**
G4	230.41	310.04	254.94	183.71	129.84	0.51	**277.37**
G5	236.14	227.98	175.71	159.08	127.24	108.68	**258.71**
G6	98.21	236.44	204.01	162.04	155.24	0.51	**214.12**
G7	118.64	198.98	196.01	111.58	88.91	82.41	**199.13**
G Total	**242.80**	**271.24**	**228.81**	**186.89**	**154.51**	**51.81**	**1988.09**

Regarding to the plumule fresh weight of okra genotypes as affected by salt stress data are present in Table 9 showed that each genotypes, increasing salt stress level led to progressively decrease in fresh weight. Amongst the genotypes, the maximum plumule fresh weight was noticed in genotype G2 (396.26 mg) which was followed by G1 (358.09 mg) while genotype G7 (199.13 mg) recorded the minimum plumule fresh weight. The plumule fresh weight values varied significantly in between different concentrations of NaCl where maximum (271.24 mg) was recorded in T1 (20 milli molar salt solution) and lowest (51.81 mg) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations plumule fresh weight was found to be significantly different. The maximum plumule fresh weight was observed in G2T0 (378.88 mg) which was followed by G2 T1 (349.98 mg). Whereas in G1T0 (337.51 mg) were found at par with G2T0 (378.88). Fresh weight of all the genotypes treated in different concentrations of salt were decreased more than 50% with respect to the controlled (non-saline). G7 genotypes at slight salt stress (20 and 40 milli molar) and the rest of the other levels of salt concentrations, biomass got reduced which indicated inflow of stress was very high. Salt stress adversely affects okra by causing osmotic and ionic stress, leading to nutrient imbalances, reduced photosynthesis, increased respiratory activity, cellular damage, and growth inhibition results in reduced weight. Similar findings where salt concentrations surges in the medium, plant absorbs lesser water that producing biomass reduction (Javed *et al.*, 2018). Salt stress limits the water availability of plant cell that may be responsible for dropping fresh weight (Azeem *et al.*, 2017).

Table 10 : Effect of different salt concentration on plumule dry weight of okra genotypes

GxT	T0	T1	T2	T3	T4	T5	T Total
G1	21.21	21.08	17.01	13.74	12.11	0.51	**21.42**
G2	38.81	33.31	35.02	30.68	27.94	21.34	**46.78**
G3	36.14	31.24	30.11	26.14	24.94	0.51	**37.27**
G4	47.38	40.04	32.91	31.54	32.18	0.51	**46.14**
G5	77.58	54.38	37.38	21.14	22.18	20.38	**58.26**
G6	44.98	31.21	22.28	21.98	23.41	0.51	**36.09**
G7	42.44	40.81	35.31	27.91	26.34	24.94	**49.44**
G Total	**44.08**	**36.01**	**30.00**	**24.73**	**24.16**	**9.81**	**295.39**

Regarding to the plumule dry weight of okra genotypes as affected by salt stress data are present in Table 10 showed that each genotypes, increasing salt led to progressively decrease in dry weight . Between the genotypes, the maximum plumule dry weight was noticed in genotype G5 (58.26 mg) which was followed by G7 (49.44 mg) while genotype G1 (21.42 mg) recorded the minimum plumule dry weight. The plumule dry weight values varied significantly in between different concentrations of NaCl where maximum (44.08 mg) was recorded in T0 (control, 0 milli molar salt solution) and lowest (9.81 mg) in T5 (100 milli molar solution of NaCl). The interaction effect between the genotypes and salt concentrations plumule dry weight was found to be significantly different. The maximum plumule dry weight was observed in G5T0 (77.58 mg) which was followed by G4 T0 (47.38 mg) . Whereas in G2T0 (38.81 mg), G5T0 (77.58 mg), G6T0 (44.98 mg) and G7T0 (42.44 mg) were found at par with G4T0 (47.38 mg). The seeds grown under +NaCl environment exhibited a decline in dry weight as compared to those under non saline conditions, furthermore, in present study these was proportionate to the increase in salinity level from 20 milli molar to 100 milli molar. Results regarding the plumule dry weight indicated that salinity stress had decreased the seedling dry weight may be due to the ionic dis balance and dry matter accumulation. Due to the different salt concentration applied on all the genotypes the salt stress significantly effected on the plumule dry weight.

Conclusion

Due to the present day, change in climatic factors, abiotic stresses are more in horticultural crops specifically the vegetable sector. Keeping this in view, the following experiment was taken to screen, the genotypes of Okra in Garo Hills Meghalaya.

This screening process provides a good scope for genetic improvement of the crop with respect to abiotic stress. The experiment was conducted at two levels in the laboratory for germination standards and in field during the crop growth. The bio chemicals were also analysed along with physical parameters to put up a strong point of justification in the research made.

The genotypes were classified into resistant tolerant and susceptible based upon overall performance at different parameters, the following conclusions were made. Among the genotypes, G2, G7 and G5 show resistant to overall aspects, including physical as well as biochemical parameters while G4 and G6 were tolerant, and G1 and G3 were susceptible.

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