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Studies on Effect of Salinity Stress on *Vigna radiata* (L.) Wilczek Cultivar, Naval

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Abstract

(*Vigna radiata* L.) Wilczek is short duration crop cultivated over world in Kharif, Rabi and Summer season. Area under mung bean cultivation is increased in india since 2019-2021. Mung bean crop is affected by biotic and abiotic factors such as salinity, water logging and drought in kharif, rabi and summer season. Salinity of the soil is abiotic the main responsible factor which reduces the seed germination, plant growth and crop yield. The salinity stress was studied in this experiment on isolated mutants from *Vigna radiata* (L.) Wilczek cultivar- Naval. The isolated mutants from mutagenic treatments of EMS, SA and Gamma radiation in M3 generation were studied. The research experiment was carried out in New Arts, Commerce and Science college Ahmednagar (MS, India 2021). The selected mutants from M3 generation were B8, B13, B19 and B21 from EMS-15, 20mM; and SA-2, 2mM respectively. The mutants were with high yield and biochemically diverse from control Cultivar-Naval. These mutants were subjected to salinity stress using Sodium chloride. Different concentrations of NaCl were used such as, NaCl- 0, 200, 225, 250 and 300 mM. The experiment was conducted in laboratory as well as in the field condition. These Mutants were tested for seed germination, vigour, electrical conductivity, seed yield. These mutants showed significant variations in said parameters as compared to control Cultivar-Naval.

Keywords: *Vigna radiata* • Naval • EMS • SA • Naval • *Sodium chloride* • Germination • Vigour • Electrical conductivity.

Introduction

(Vigna radiata L.) Wilczek (2n=22) is leguminous crop belongs to family Leguminosae and cultivated in tropical and subtropical areas of world [1]. Mung bean seed is high source of protein, carbohydrate, minerals and vitamins [1]. Biotic and Abiotic factors seriously affect the agricultural crop productivity of any crop. The legume crop production is affected by soil salinity, water logging, high temperature and drought [2]. The understanding of physiological and biochemical mechanisms regulating salinity and heat tolerance stresses will contribute to an evolving gene profile, protein profile and mung bean survival metabolites [2]. Due to human interferences and natural salinity; the arable field is continuously transforming into high saline filed condition, that expected to have overwhelming global effects, resulting in upto 50% land loss by 2050 [3,4]. The anthropogenic activities by mining, deforestation, construction, transportation, industry and habitations has direct and great impact on increasing high soil salinity which results direct influence on the seed germination and vegetative growth of crop plants including field crop and vegetables which leads the unbalanced soil ecology [5]. The data on salt tolerance of mung bean has been reported by various researchers. In all these studies the effect of salinity on seed germination and vegetative growth of mung bean plant has been reported [1,6-8].

In this article, effect of various NaCl concentrations on seed germination, vigor, plant vegetative growth and seed yield of mung bean mutants of cultivar-Naval have been presented with their quantitative characters.

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Materials and Methods

Seed collection

The seeds of mung bean mutants obtained from mung bean cultivar-Naval, M2 generation of mutagenic treatment EMS-15, 20 and SA-2 mM concentrations were made available. The mutants were selected on high yield performance. These mutants were B8, B13, B19 and B21. After M3 generation trial, seed yield salinity and biochemical performance of these mutants were studied.

Seed sowing

In laboratory condition: Control and mutant seeds wre rinsed under running water for 05 minutes, sterilized with 05% sodium hypochlorite for 10 minutes and washed three times with sterile distilled water. Concentration of NaCl was prepared in 0mM, 200, 225, 250 and 300 mM for mutants and control cultivar [9]. Seeds of control (Naval) and mutants were subjected to germination in deepened/moistened germination (Towel) paper in required concentrations such as; 0, 200, 225, 250 and 300 mM. 200 seeds of each mutant including control were placed in two replications on moistened germination paper and rolled it with plastic covering and kept in upright position in tray. The germinator was maintained at 22-28°C±1 with 70 to 85% humidity. After 4-7th days, seed germination and vigor was calculated by fresh weight, seedling length (root-shoot). The seedlings were kept for drying in hot air oven at 100°C±1 for 24 hours. After; dried weight measured in gm. The vigor index of mass and length, salinity tolerance index was calculated. The suitable concentrations 200 and 225mM was selected for pot experiment on the basis of minimum germination percentage of mung bean (75%) as per ISTA and IMSCS.

In field/pot culture condition

Control and mutant seeds were rinsed under running water for 05 minutes and sterilized the seeds with 05% sodium hypochlorite for 10 minutes, washed three times with sterile water. The sterilized seeds of each mutant including control were placed in 20 cm diameter plastic pot containing sand and petri plates on filter paper saturated with sterile water and kept it in darkness at 22-28°C±1 until germination (4-7th day). After 4-7th days, old seedlings were transferred to a separate sterilized soil pots and these pots were kept in growth chamber at 22-28°C±1 for 16 hours with light and 8 hours without light with 60-

90% relative humidity, under 200-450 µmol m-2 s-1 light intensity and supplied with 100 ml ¼ Hoagland medium to soil in a day. Potted plants were allowed to grow up to 3-10 leaves stage (2-3 weeks) for salinity assays [1,10-12]. Salinity was started at increments of 10 mM NaCl at 3 hr. interval and maximum 50 mM NaCl in each treatment at 24 hours and each treatment was replicated thrice with three plants in each pot. The final salt concentration maintained was 0, 200, 225, 250 and 300mM NaCl in addition to the ½ Hoagland solution [8]. Excess solution was used to maintained salinity level in pots. Water loss in pots was recovered every week by addition of distilled water [1]. The observations were made from seed germination up to harvesting stage. Quantitative parameters such as plant height (cm), number of primary branches, number of leaves, days to flowering and 50%, days to maturity, number of clusters, pods per cluster, pods per plant, pod length (cm), seeds per pod, seed index/ 100 seed weight (gm), seed yield per plant (gm) were studied and recorded in salinity tolerance tested mutant and control Naval were recorded [1,10].

Statistical analysis

Mean, standard deviation, standard error of treatment of each mutant was calculated, including control. The statistical analysis was carried out method suggested by Rastogi [11].

Results and Discussion

The results of experiment were recorded in the form of seedling mass wt. (gm), total seedling length (cm), vigor index (length, mass), root shoot ratio, dry wt (gm), PH and (EC) electrical conductivity. The results showed variation in control and mutants have been presented in table. Germination percentage was high in as all mutants compared to control. Total mass wt (gm) of control was 0.11(gm) in 225 mM. The highest total mass was obtained 0.15, 0.14, 0.17 and 0.19(gm) in 225 mM in mutant B8, 13, B19 and B21 respectively. Highest seedling length was found in control 6.41 cm in 225 Mm. Mutant showed 8.46, 8.04, 8.47 and 8.58 cm. in 200 mM in B8, B13, B19 and B21 respectively. Similar results were obtained by Salim and Pitmam [1]. The vigor index length and mass also showed high in 200 mM concentration of mutants are depicted in Table 1. Similar results of variation in vigor index showed by NaCl concentrations [2,10]. Root-shoot ratio was 279.29 in 225 mm of control, 279.52 in 225 mm B8, 349.16 in 200 mm B13, 326.96 in 225 mm B19, 367.15 in 225 mm B21. Seedling dry weight in control was 0.10 gm. In 200 and 225 mm and 0.15, 0.14, 0.15, 0.17 gm in 225 mm in B8, B13, B19 and B21 respectively. The pH and electrical conductivity was found significant in control as well as mutants showed in Table 1.

Quantitative parameters such as; plant height(cm), number of primary branches, No. of leaves, days to flowering & 50%, days to maturity, No. of clusters, pods per cluster, pods per plant, pod length (cm), seeds per pod, seed index/ 100 seed weight (gm), seed yield per plant (gm) were studied and recorded in salinity tolerance tested mutants and control of Vigna radiata (L.) Wilczek. Mutant B8, B13, B19 and B21 were tested for 0, 200 and 225 mM NaCl concentrations in pot level. Seed germination was high in mutants as compared to control. The plant height was 16.5 cm in 200 mm of control. Mutant B8, B13, B19 and B21 showed plant height 25.5, 20.5, 20.5 and 21.5 cm respectively. Plant height changes in NaCl concentrations have been reported in Mung bean [1,9]. The number of primary branches and number of leaves were significantly increased in mutants as compared to control showed in Table 2. The early flowering was found in mutant B13, B19 and B21 in 200 mm concentration. The maturity time of control and mutants was found significantly different but mutant showed early maturity at 69 days as showed in Table 2. The number of clusters and pods per cluster were increased in mutants as compared to control. The number of pods per plant was 12 in B8 and B13 in 200 mm NaCl concentration and in other mutants and in control it was 9. The pod length was found 10 and 9.5 cm in B19 and B21 in 200 mm. the seeds per pod normally increased in mutants B19 and B21 as showed in Table 2. The seed index in control was 4.10 gm in 200 mm and in mutants it was

Table 1: Effect of Sodium chloride (NaCl) on Seed germination and Vigour of Mutants *Vigna radiata* (L.) Wilczek.

Date- 01/05/2021				Count I- 5/05/2021			Count II- 8/05/2021							
Mutant	Conc. of NaCl	Ger.%	Wt. of Plumule (gm.)	Wt. of Radical (gm.)	Total Mass Wt. (gm.)	Length of Plumule (cm.)	Length of Radical (cm.)	Total Length (cm.)	Vigour Index length	Vigour Index Mass	Root-Shoot Ratio	Dry Wt. (gm.)	P.H	E.C
Control	0mM	90.00	0.25	0.06	0.31	19.56	9.44	29.00	2900.00	16.45	48.26	0.16	7.38	51.09
	200mM	80.00	0.06	0.04	0.11	1.73	4.50	6.23	498.40	7.62	260.12	0.10	7.38	51.09
	225mM	75.00	0.06	0.05	0.10	1.69	4.72	6.41	544.85	8.47	279.29	0.10	7.38	51.09
S.D.±		*7.64*	*0.11*	*0.01*	*0.12*	*10.31*	*2.79*	*13.09*	*1373.35*	*4.87*	*128.21*	*0.04*	*0.00*	*0.00*
S.E.±		*4.41*	*0.06*	*0.01*	*0.07*	*5.95*	*1.61*	*7.56*	*792.93*	*2.81*	*74.02*	*0.02*	*0.00*	*0.00*
B8	0mM	100.00	0.23	0.05	0.28	20.10	10.82	30.92	3092.00	16.93	53.83	0.17	7.30	51.59
	200mM	90.00	0.08	0.07	0.15	2.39	6.07	8.46	719.10	12.99	253.97	0.15	7.30	51.59
	225mM	85.00	0.06	0.04	0.10	1.66	4.64	6.30	409.50	6.71	279.52	0.10	7.30	51.59
S.D.±		*7.64*	*0.09*	*0.02*	*0.09*	*10.44*	*3.24*	*13.63*	*1467.56*	*5.15*	*123.59*	*0.03*	*0.00*	*0.00*
S.E.±		*4.41*	*0.05*	*0.01*	*0.05*	*6.03*	*1.87*	*7.87*	*847.32*	*2.98*	*71.36*	*0.02*	*0.00*	*0.00*
B13	0mM	100.00	0.27	0.06	0.33	18.60	9.89	28.49	2849.00	17.18	53.17	0.17	7.28	54.95
	200mM	90.00	0.07	0.07	0.14	1.79	6.25	8.04	603.00	10.76	349.16	0.14	7.28	54.95
	225mM	85.00	0.05	0.05	0.10	1.49	5.15	6.64	597.60	9.36	345.64	0.10	7.28	54.95
S.D.±		*7.64*	*0.12*	*0.01*	*0.12*	*9.79*	*2.48*	*12.23*	*1298.29*	*4.17*	*169.88*	*0.03*	*0.00*	*0.00*
S.E.±		*4.41*	*0.07*	*0.01*	*0.07*	*5.65*	*1.43*	*7.06*	*749.59*	*2.41*	*98.08*	*0.02*	*0.00*	*0.00*
B19	0mM	100.00	0.29	0.08	0.37	17.01	9.86	26.87	2552.65	21.42	57.97	0.26	7.33	64.77
	200mM	95.00	0.09	0.09	0.17	2.38	6.09	8.47	677.60	11.85	255.88	0.15	7.33	64.77
	225mM	85.00	0.05	0.05	0.10	1.28	4.18	5.46	354.61	6.12	326.96	0.09	7.33	64.77
S.D.±		*7.64*	*0.13*	*0.02*	*0.14*	*8.78*	*2.89*	*11.59*	*1186.84*	*7.73*	*139.39*	*0.08*	*0.00*	*0.00*
S.E.±		*4.41*	*0.07*	*0.01*	*0.08*	*5.07*	*1.67*	*6.69*	*685.24*	*4.46*	*80.48*	*0.05*	*0.00*	*0.00*
B21	0mM	95.00	0.25	0.08	0.33	18.42	10.92	29.34	2787.30	19.52	59.28	0.21	7.35	51.32
	200mM	90.00	0.11	0.08	0.19	2.73	5.85	8.58	815.10	16.20	214.29	0.17	7.35	51.32
	225mM	85.00	0.06	0.06	0.11	1.37	5.03	6.40	544.00	10.40	367.15	0.12	7.35	51.32
S.D.±		*5.00*	*0.10*	*0.01*	*0.11*	*9.48*	*3.19*	*12.66*	*1224.44*	*4.62*	*153.94*	*0.04*	*0.00*	*0.00*
S.E.±		*2.89*	*0.06*	*0.01*	*0.06*	*5.47*	*1.84*	*7.31*	*706.95*	*2.67*	*88.88*	*0.02*	*0.00*	*0.00*

Table 2: Effect of Sodium chloride (NaCl) on Quantitative Characters of Mutants *Vigna radiata* (L.) Wilczek.

Date- 01/05/2021				Count I- 5/05/2021											
Mutant	**Conc. of NaCl**	**Ger. %**	**Plant height (cm)**	**Primary branches**	**No. of Leaves**	**Days to flowering 1ST & 50 %**	**Days to maturity**	**No. of clusters**	**Pods per cluster**	**Pods per plant**	**Pod length (cm)**	**Seeds per pod**	**10 seed**	**Seed index**	**seed yield per plant (gm.)**
Control	0mM	90.00	29.0	2	4	42	68	3	3	9	10.00	10	0.444	4.440	1.40
	200mM	80.00	16.5	2	4	44	70	3	3	9	9.00	10	0.410	4.100	1.35
	225mM	75.00	15.5	2	4	45	72	3	3	9	9.00	10	0.398	3.980	1.28
SD±		*7.64*	*7.52*	*0.00*	*0.00*	*1.53*	*2.00*	*0.00*	*0.00*	*0.00*	*0.58*	*0.00*	*0.02*	*0.24*	*0.06*
SE±		*4.41*	*4.34*	*0.00*	*0.00*	*0.88*	*1.15*	*0.00*	*0.00*	*0.00*	*0.33*	*0.00*	*0.01*	*0.14*	*0.03*
B8	0mM	95.00	31.0	3	5	45	72	4	4	16	7.00	10	0.540	5.400	1.55
	200mM	90.00	25.5	3	5	46	73	3	4	12	7.00	9	0.520	5.200	1.48
	225mM	85.00	20.5	2	4	47	75	3	3	9	6.00	9	0.490	4.900	1.44
SD±		*5.00*	*5.25*	*0.58*	*0.58*	*1.00*	*1.53*	*0.58*	*0.58*	*3.51*	*0.58*	*0.58*	*0.03*	*0.25*	*0.06*
SE±		*2.89*	*3.03*	*0.33*	*0.33*	*0.58*	*0.88*	*0.33*	*0.33*	*2.03*	*0.33*	*0.33*	*0.01*	*0.15*	*0.03*
B13	0mM	95.00	28.5	3	5	43	70	3	5	15	8.00	9	0.550	5.500	1.54
	200mM	90.00	20.5	2	4	43	71	3	4	12	7.00	9	0.530	5.300	1.44
	225mM	85.00	18.5	2	4	44	72	3	4	12	6.00	8	0.495	4.950	1.35
SD±		*5.00*	*5.29*	*0.58*	*0.58*	*0.58*	*1.00*	*0.00*	*0.58*	*1.73*	*1.00*	*0.58*	*0.03*	*0.28*	*0.10*
SE±		*2.89*	*3.06*	*0.33*	*0.33*	*0.33*	*0.58*	*0.00*	*0.33*	*1.00*	*0.58*	*0.33*	*0.02*	*0.16*	*0.05*
B19	0mM	100.00	27.0	3	4	42	68	3	4	12	11.00	12	0.450	4.500	1.65
	200mM	95.00	20.5	3	4	42	69	3	3	9	10.00	11	0.444	4.440	1.44
	225mM	85.00	15.5	3	4	43	70	3	3	9	10.00	10	0.410	4.100	1.42
SD±		*7.64*	*5.77*	*0.00*	*0.00*	*0.58*	*1.00*	*0.00*	*0.58*	*1.73*	*0.58*	*1.00*	*0.02*	*0.22*	*0.13*
SE±		*4.41*	*3.33*	*0.00*	*0.00*	*0.33*	*0.58*	*0.00*	*0.33*	*1.00*	*0.33*	*0.58*	*0.01*	*0.12*	*0.07*
B21	0mM	95.00	30.0	3	4	42	68	3	4	12	10.00	11	0.510	5.100	1.51
	200mM	90.00	21.5	3	4	43	70	3	3	9	9.50	10	0.490	4.900	1.43
	225mM	85.00	15.5	3	4	43	71	3	3	9	9.00	10	0.480	4.800	1.41
SD±		*5.00*	*7.29*	*0.00*	*0.00*	*0.58*	*1.53*	*0.00*	*0.58*	*1.73*	*0.50*	*0.58*	*0.02*	*0.15*	*0.05*
SE±		*2.89*	*4.21*	*0.00*	*0.00*	*0.33*	*0.88*	*0.00*	*0.33*	*1.00*	*0.29*	*0.33*	*0.01*	*0.09*	*0.03*

5.20, 5.30, 4.44 and 4.90 gm. respectively in 200 mm concentration. The seed yield per plant was also average high in mutants B8, B13, B19 and B21 (1.48, 1.44, 1.44 and 1.43 gm.) in 200 mm of NaCl concentration. Similar results on quantitative parameters were reported by [1,9,10].

Conclusion

From this experiment; it can be concluded that, the soil containing maximum content of NaCl affects the seed germination and vigor parameters and ultimately leads in reduction quantitative parameters and in crop yield. The high level of NaCl present in the soil can damage the annual crop system. Mutants B8, B13 B19 and B21 in 200 and 225 mM showed good performance in seed germination, vigor and quantitative parameters as compared to control. With the help of results found in this experiment, it can be concluded that the mutants tolerate the different salinity levels. The 200 mM concentration of NaCl showed significant results as compared to 225mM in this study. So, it can be concluded that, the mutants studied in this experiment tolerate to high salinity concentration as compared to control of cultivar of mung bean Naval. Results obtained in present investigation of abiotic stress show that; the mutants can tolerate saline soil. These types of mutants are very useful in plant breeding programme and farmers for cultivation.

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