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Screening of Black Gram (*Vigna Mungo* L. Hepper) Varieties for Tolerance to Salinity

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ABSTRACT

Salinity is one of the most important abiotic stress that affects the yield in most of the crops under cultivation. The area under black gram (*Vigna mungo* L. Hepper) is decreasing in recent years due to soil salinity problem. Thirteen black gram genotypes *viz*., VBN1, VBN2, VBN3, VBN(Bg) 4, VBN(Bg) 5, VBN(Bg) 6, VBN 7 and VBN 8, VBG 12-034, VBG 12-062, VBG 12-110, VBG 12-111, VBG 13-003 and VBG 14-016 were screened under three EC level (4.0 EC, 11.0 EC and 16.0 EC) and compared with 0.0 EC (control). The mean germination percentage of all the thirteen genotypes studied illustrated reduced level of germination percentage with increasing salinity level. At the highest salinity level (16.0 EC) the germination percentage was significantly affected compared to 4.0 EC and 11.0 EC. The grand mean of plumule length was more at 4.0 EC and was reduced to half (16.0 EC) as compared to control. The root grew longer at 11.0 EC (4.91 cm) as compared to 4.0 EC (4.83 cm) and 0.0 EC (3.02 cm), where ever showed drastic reduction at 16.0 EC (1.92 cm). The grand mean value of dry matter weight increased concomitantly with salinity. The radical length had positive and significant correlation with dry matter weight at 11.0 EC (0.657) where as positive and non-significant correlation with 4.0 and 16.0 EC suggested that radicle length is the most useful parameter to select salinity tolerant black gram genotypes. Based on grand mean performance of the thirteen genotypes evaluated, the genotype VBG-14-016 followed by Vamban 4, Vamban 8 and VBG-12-062 outperformed than all other genotypes, while VBG-13-003 was highly susceptible followed by VBG-12-034.

Key words: Black gram, EC level, Germination percentage, Plumule length, Radical length, Salinity, Simple correlation.

INTRODUCTION

Salinity is becoming a global issue due to climate change. Globally more than 800 million hectares of land is affected by salt that affects crop productivity. Almost all the crops fit for human consumption are sensitive to high salt concentration in the soil. The area under salinity is increasing at the rate of 10 per cent annually due to various reasons including low precipitation, weathering of native rocks, irrigation with saline water, poor cultural practices and natural calamities like Tsunami and cyclones. It has been estimated that by the year 2050, more than 50 per cent of the arable land would be brought under salinity stress (Jamil *et al.,* 2011).

In India, 6.73 million hectare is affected due to high salt concentration, of which 1.71 million hectare area is saline, 3.78 million hectare is alkali and 1.25 million hectare belongs to coastal saline. In Tamil Nadu, 35.5 lakh hectares are affected due to alkalinity and 13.2 thousand hectares area are affected by coastal salinity (cssri.org). Pulses play a significant role in Indian agriculture and only source of dietary protein to majority vegetarian population. Among the pulses, black gram is one of the important tropical leguminous crops widely cultivated in Indian subcontinent. In Tamil Nadu the area under black gram is 3.95 hectares with the productivity of 2.76 lakh tonnes and productivity is 699 kg/ha (https://community.data.gov.in/area) more than one lakh hectare black gram is cultivated as rice fallow crop in the costal districts of Thanjavur, Nagapattinam, Thiruvarur and Cuddalore districts. In these areas due to non availability of Cauvery water in the recent years the farmers are opted for bore well irrigation to raise the crops throughout the year. Most of the bore well water is saline due to intrusion of sea water the area under salinity is increasing year by year and the level of salinity is also increased constantly. Salinity is one of the major limiting factor leads to minimize the area under black gram and also production. Because of inadequate information available on black gram varietal differences regarding the salt injury / tolerance it is very difficult to identify the suitable variety for this region. The genetic diversity for salinity tolerance was analyzed in black gram varieties and advanced cultures for cultivation in salt-affected areas.

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MATERIALS AND METHODS

The experimental material comprised of eight popular varieties (VBN1, VBN2, VBN3, VBN(Bg)4, VBN(Bg)5, VBN(Bg)6, VBN 7 and VBN 8) and of five advanced pipeline cultures (VBG 12-034, VBG 12-062, VBG 12-110, VBG 12-111, VBG 13-003, VBG 14-016) of black gram collected form National Pulses Research Centre, Vamban and the experiment was conducted at Agricultural College and Research Institute, Kudumiyanmalai during the year 2018-19 its Latitude is 10.38 North and Longitude is 78.82. Thirteen genotypes were screened using a combination of salts *viz*., NaCl, Na_2SO_4, KCl, K_2SO_4, $MgCl_2$, $MgSO_4$ and $CaCl_2$ in the ratio of 2:1:1:1:1:1:1, respectively dissolved in deionized water to of 100 ml solution (Singh *et al.* 2009), to create EC of 4.0 ds/m level 0.075 g of NaCl and 0.037 g for the remaining salts dissolved in the 100 ml of deionised water. Similarly for 11.0 ds/m EC, 0.175 g of NaCl and 0.0875 g of other salts were dissolved in the 100 ml of deionised water, 16.0 ds/m EC was achieved by dissolving 0.25 g of NaCl and 0.125 g of remaining salts were dissolved in the 100 ml of deionised water and deionised water is used as control (0.00 EC) with no salts. Screening was done in petri dish (germination sheet placed inside the petri dish) with two replications and a total of 25 seeds were sown in each replication of each treatment. The respective saline solution was added to the petri dish and keeps the germination sheet wet till the observation were recorded. The germination and seedling behaviour *viz*., germination percentage, plumule length, radical length, plumule-radicle length ratio and dry matter weight were recorded after eight days of incubation in all four EC levels in both replications. The data obtained from the genotypes grown under different EC levels were subjected to two factorial analysis of variation (Gomez and Gomez, 1984) was calculated using the statistical package TNAUSTAT (developed by Prof. N. Manivannan). Simple linear correlation coefficient was computed to determine the association among the characters at different salt concentration levels suggested by Goulden (1952).

RESULTS AND DISCUSSION

The research on black gram for salt tolerance is scanty and the present study may help to identify the salt tolerant genotype to the saline areas. Thirteen popular varieties of Tamil Nadu and advanced cultures were subjected to screening at four EC level (0.0 EC, 4.0 EC, 11.0 EC and 16.0 EC) and response of five different parameters (germination percentage, plumule length, radical length, plumule-radicle length ratio and dry matter weight) were recorded (Table 1-5). The experimental results revealed that the black gram is highly sensitive to salinity like other legume crops (Promila and Kumar, 2000).

Analysis of variance revealed that the mean squares among the genotypes studied at four salt concentrations were significant for all the five parameters (Table 1). The coefficient of variation varied among data from different characters and maximum for radical length (12.77) followed by plumule length (10.87) and the minimum coefficient of variation was recorded in dry matter weight (5.36). These results inferred that genotypes gave a different response towards varying salinity level. The critical difference (CD) for all the characters compared different factorial plots and subplots with their interactions (Table 1) indicated that all the genotypes behave differently under different salinity level.

Table 1: Analysis of variance of different characters and various salt concentrations in black gram genotypes.

Characters		Genotypes (13)	Salt concent -rations (4)	Interaction (36)	Error (51)	Total (104)	Coefficient of variation
Germination (%)	MS	335.64**	249.74**	49.52**	37.9094	8493.8005	6.7594
	SEM	2.1769	1.2075	4.3537			
	CD	6.0955	3.3812	12.1910			
Plumule length (cm)	MS	4.89**	162.38**	2.52**	0.3530	656.4502	10.8731
	SEM	0.2101	0.1165	0.4201			
	CD	0.5882	0.3263	1.1764			
Radicle length (cm)	MS	1.8685	77.2320	1.6594	0.2427	327.0189	12.7731
	SEM	0.1742	0.0966	0.3483			
	CD	0.4877	0.2705	0.3593			
Plumule-radicle length ratio	MS	0.23**	11.51**	0.32**	0.0342	50.8411	12.14
	SEM	0.0654	0.0363	0.1307			
	CD	0.1830	0.1015	0.3660			
Dry weight (g)	MS	0.05**	0.0608**	0.0339**	0.0025	2.1626	5.36
	SEM	0.0175	0.0097	0.0350			
	CD	0.0490	0.0272	0.0981			

*, ** Significance at 0.01 and 0.05 per cent level, respectively.

MS: Mean standard; SEM: Standard error of mean; CD: Critical difference.

Table 2: Mean germination percentage of black gram genotypes at different levels of salt concentration.

Name of the genotype	Salt concentration			
	Control	4 EC	11 EC	16 EC
VBN 2	90	90	80	70
VBN 3	97	90	97	80
VBN 4	97	97	90	83
VBN 5	97	97	97	87
VBN 6	93	97	87	87
VBN 7	90	87	83	83
VBN 8	97	90	87	80
VBG 12-34	97	97	90	80
VBG 12-62	97	97	90	87
VBG 12-110	90	87	97	87
VBG 12-111	90	90	97	80
VBG 13 -003	97	90	97	83
VBG 14-016	97	97	97	87
Grand Mean	94	92	91	83

Table 3: Mean plumule length (cm) for black gram genotypes at different levels of salt concentration.

Name of the genotype	Salt concentration			
	Control	4 EC	11 EC	16 EC
VBN 2	5.355	6.625	5.728	2.640
VBN 3	5.455	6.625	4.220	3.000
VBN 4	6.900	8.700	5.825	2.455
VBN 5	6.700	8.750	5.480	2.700
VBN 6	7.475	9.075	5.685	3.000
VBN 7	7.350	7.875	4.995	1.800
VBN 8	6.475	6.725	3.775	1.735
VBG 12-34	7.950	5.075	4.175	1.800
VBG 12-62	8.400	5.475	5.600	1.850
VBG 12-110	5.725	5.325	4.650	1.160
VBG 12-111	5.850	9.385	5.625	1.875
VBG 13-003	8.325	8.000	4.925	1.250
VBG 14-016	11.475	9.725	5.800	1.600
Grand mean	7.187	7.489	5.114	2.067

The mean germination percentage of all the thirteen genotypes compared results recorded that increasing salinity level affect the germination percentage and at 16.0 EC level the germination was significantly (83 %) affected compared to 4.0 EC (92 %) and 11.0 EC (91 %) where as control recorded 94 %. The results proved that at lower salt concentration represented by 4.0 EC did not affect germination per cent and as EC levels increased germination was severely affected. Significant reduction in germination percentage with increasing salinity was also observed in green gram (Shekhar, 1994) and black gram (Sarkar and Shukla 1997; Dash and Panda 2001). Among 13 genotypes VBN(Bg) 4, VBN (Bg) 6, VBG 12-062, VBG 12-110, VBG 14-016 performed better with 87 percentage of germination and the variety VBN 2 was affected severely (70 %).

The grand mean of plumule length more at 4.0 EC and was reduced to half at 16.0 EC as compared to control (Table 3). A Similar pattern was also observed in plumule - radicle length ratio (Table 5). The root length was 4.9 cm at 11.0 EC and this was longer than control (3.02 cm) and 4.0 EC (4.83 cm) and at 16.0 EC the root length was drastically reduced at 16.00 EC (1.92 cm). These findings showed that increasing salinity level increased the radical length but beyond certain level this growth was drastically reduced. Increasing salt level in soil affects nutrient uptake there by stimulate root length leads to increased root growth for better nutrient uptake. The grand mean value of dry matter weight increased concomitantly with salinity (Table 6). These findings can be attributed to an increase in salt concentration, where in ions get accumulated and shoot length is more affected with ion toxicity than root length. It was observed in maize by Maiti *et al*., (1996) and they explained it as a mechanical resistance for maintaining osmoregulation while increase in dry matter weight with salinity was also noticed by Shekhar, (1994) in green gram seedlings.

Table 4: Mean radicle length (cm) for black gram genotypes at different levels of salt concentration.

Name of the genotype	Salt concentration			
	Control	4 EC	11 EC	16 EC
VBN 2	2.815	4.735	4.570	2.747
VBN 3	2.525	4.125	5.585	2.635
VBN 4	3.975	5.125	5.900	1.810
VBN 5	2.995	6.375	4.915	2.300
VBN 6	2.850	5.350	5.075	1.765
VBN 7	2.925	5.375	4.425	1.600
VBN 8	2.275	4.425	3.825	2.030
VBG 12-34	3.475	5.475	6.600	1.075
VBG 12-62	2.725	3.975	4.125	1.350
VBG 12-110	2.675	3.525	3.975	1.128
VBG 12-111	2.875	5.350	4.625	2.215
VBG 13-003	2.850	4.250	5.400	2.000
VBG 14-016	4.300	4.700	5.475	2.410
Grand mean	3.020	4.830	4.961	1.928

Table 5: Mean plumule-radicle length (P-R) ratio for black gram genotypes at different levels of salt concentration.

Name of genotypes	Salt concentration			
	Control	4 EC	11 EC	16 EC
VBN 2	1.902	1.399	1.253	0.961
VBN 3	2.160	1.606	0.756	1.139
VBN 4	1.736	1.698	1.099	1.356
VBN 5	2.237	1.373	1.115	1.174
VBN 6	2.623	1.696	1.120	1.700
VBN 7	2.513	1.465	1.129	1.125
VBN 8	2.846	1.520	0.987	0.855
VBG 12-34	2.288	0.927	0.633	1.674
VBG 12-62	3.083	1.377	1.358	1.370
VBG 12-110	2.140	1.511	1.563	1.028
VBG 12-111	2.035	1.478	1.216	0.847
VBG 13-003	2.921	1.882	0.912	0.625
VBG 14-016	2.669	2.069	1.059	0.664
Grand mean	2.396	1.539	1.092	1.117

Table 6: Mean dry matter weight (g) for black gram genotypes (15 seedlings) at different levels of salt concentration.

Name of the genotype	Salt concentration			
	Control	4 EC	11 EC	16 EC
VBN 2	0.884	0.868	0.908	0.952
VBN 3	0.943	0.939	0.996	0.954
VBN 4	0.892	0.853	0.925	0.961
VBN 5	0.873	0.870	0.879	0.896
VBN 6	0.878	0.895	0.909	0.922
VBN 7	0.755	0.866	0.888	0.918
VBN 8	0.866	0.876	0.878	0.948
VBG 12-34	0.859	0.885	0.898	0.973
VBG 12-62	0.880	0.914	0.914	0.928
VBG 12-110	0.890	0.911	0.797	0.975
VBG 12-111	0.868	0.864	0.893	0.925
VBG 13 -003	0.914	0.914	0.925	0.964
VBG 14-016	0.902	0.876	1.860	1.087
Grand mean	0.878	0.887	0.975	0.954

Table 7: Simple linear correlation coefficient among 5 characters in 13 genotypes of black gram at different salt concentrations.

Characters	Salt concent--rations (EC)	Plumule length (cm)	Radicle length (cm)	Plumule radicle length ratio	Dry matter weight (g)
Germination percentage	0 EC	0.455*	0.273	0.366	0.453*
	4 EC	0.226	0.421*	-0.024	-0.164
	11 EC	-0.057	0.208	-0.066	0.271
	16 EC	-0.220	-0.449*	0.165	0.084
Plumule length (cm)	0 EC		0.655**	0.573*	-0.011
	4 EC		0.516*	0.636*	-0.474*
	11 EC		0.016	0.475*	0.293
	16 EC		0.486*	0.482*	-0.393
Radicle length (cm)	0 EC			-0.228	0.046
	4 EC			-0.279	0.657*
	11 EC			-0.736**	0.269
	16 EC			-0.510*	0.103
Plumule radicle length ratio	0 EC				-0.080
	4 EC				0.090
	11 EC				-0.141
	16 EC				-0.389

*, ** Significance at 0.1 and 0.01 per cent level respectively.

Simple linear correlation coefficient among 5 characters in 13 genotypes of black gram at different salt concentrations

Simple linear correlation co-efficient determined for five characters at different salt concentrations revealed that germination percentage had significantly positive correlation with radical length (0.421) at 4.0 EC level with concomitant non negative and non significant correlation with P-R length ratio at 4.0 and 11.0 EC level (Table 7). The radical length had positive and significant correlation with dry matter weight at 16.0 EC level and positive and non significant correlation with higher EC level suggested that radicle length is the most useful parameter to evaluate salt tolerant cultivars of crop plants. Similar finding was also reported by Singh *et al.* (2009); Kuhad and Sheoran; (1987); Freitas and Camargo, (1988); Shekhar (1994). Positive correlation of germination and radicle length at higher salt concentrations also support the possible selection criteria for salt tolerance in black gram. Any one of the character showing positive significant effect may help to improve salt tolerance in crop plants (Shanthi *et al.,* 2011). Studying the variation among cultivated varieties and advanced cultures may help to identify the suitable genotype for problem soils and also these genotypes may serve as a donor for development of saline tolerant varieties (Shanthi *et al*., 2006).

CONCLUSION

The effect of different levels of salinity on black gram showed that at lower EC levels up to (11.0 EC) the germination was not much affected beyond that the germination also affected. Based on grand mean performance among the thirteen genotypes evaluated, the genotype VBG-14-016 followed by Vamban 4, Vamban 8 and VBG-12-062 were performed better and VBG-13-003 was affected more due to increasing salt concentration followed by VBG-12-034. Hence these tolerant genotypes may be recommended for saline soil areas.

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