J. Farm Sci., 35(2): (169-173) 2022

RESEARCH PAPER

Genetic variability studies for yield and its attributes under salt affected soils in wheat species

SRIVIJAY MALIPATIL, S. S. BIRADAR, S. A. DESAI AND S. S. GUNDLUR

Department of Genetics and Plant Breeding, College of Agriculture
University of Agricultural Sciences, Dharwad - 580 005, Karnataka, India
E-mail: srivijay7560@gmail.com

(Received: November, 2021 ; Accepted: May, 2022)

Abstract: Salinity is one of the most important abiotic stresses affecting crop yield and quality. Wheat is regarded as a moderately salt tolerant crop; wheat species exhibit high variability that can be conveniently explored to improve wheat species for salt tolerance. Hence, the magnitude of variability for salt tolerance was studied in wheat germplasm accessions of three cultivated species. High phenotypic and genotypic coefficient of variance were observed for grain yield and yield attributes like tillers per meter, biomass, spikelets per spike and harvest index. The heritability and genetic advance over mean were moderate to high for grain yield, thousand grain weight, tillers per meter, biomass, spikelets per spike, harvest index, plant height, days to 50 per cent flowering and days to maturity. Thus, the present study provide valuable genetic resources for grain yield and yield parameters improvement which are associated with the salt tolerance in wheat species.

Key words: Attributes, Genetic variability, Salt affected soil, Wheat, Yield

Introduction

India is the world's second-largest producer of wheat, following China, because of its diversified agroecological conditions. Particularly in recent years, has maintained food and nutritional security for majority of Indians through production and consistent supply (Sharmaand Singh, 2015 and Ramadas *et al.*, 2019). Wheat occupies prime position among food crops in India. The crop was grown on about 30 million ha. (14 per cent of global land) to produce 107.70 million tonnes of wheat (13.54 per cent of global production) with a record average productivity of 3371 kg per ha. (MoA&FW, 2018).

According to estimation of FAO (2011) and Rosegrant *et al.* (1995), the global wheat productivity must increase by at least 1.6 per cent annually to meet the increasing demand for food under shrinking cultivable land area. It is imperative in this context to look for tools not only to increase the crop productivity but also to ensure protection against loss of potential productivity due to environmental vagaries *i.e.,* salinity and sodicity of soil.

In our country, wheat production is limited by various environmental stresses. Salinity is the presence of minerals at high levels (cations: Na, K, Ca and anions: Cl, HCO_3, SO_4) in soil or water. Among abiotic stresses, salinity is one of the major factors reducing plant growth and productivity worldwide and affect about 1.1billion ha of land which is 6 to 7 per cent of continental surface soil. About 20 per cent of irrigated land is affected by salt stress and it may rise up to 50 per cent by mid-20th century (Singh *et al.*, 2016). In India, about 6.75 M ha of land is affected by salt, out of which 3.77 M ha and 2.96 M ha of land is affected by sodicity and salinity respectively (Mondal *et al.*, 2010).As a consequence of these characteristics, the work was initiated to identify new genetic sources in germplasms of wheat species for salt tolerance that are being unexplored. Further, such information may be great to set the future path for the salt tolerance breeding program in wheat.

Material and methods

The present study included 140 wheat germplasm accessions under both saline (natural saline soils) and control plot.Out of which, 32 were bread wheat, 47 durum wheat, 50 dicoccum wheat and 11 checks (Table1) which were evaluated in alpha lattice design with two replications.All the test genotypes were grown in 5 blocks within replication with 28 genotypes per block. All the individual genotypes were grown in 2 rows of 3-meter length with a spacing of 20 cm between rows. The investigation was carried out during *rabi* 2020-21 at the Ugar Sugars Pvt. Ltd, Ugar Khurd, Tq-Chikkodi, Dt-Belagavi, Karnataka, which is situated in the northern transitional tract of Karnataka with 16°38' N latitude and 74° 49' E longitude at an altitude of 537 m above mean sea level (AMSL). Under saline condition, pH of the soil is less than 8 and EC of>4 dS/m and under control condition pH of 6-8 and EC of <4 dS/m was maintained. The pH and EC dS/m of top layer (0-20 cm) and bottom layer (20-40 cm) of control and saline field (Table 2).

Morphological traits like germination per cent, days to fifty per cent flowering, days to maturity and plant height, physiological traits (SPAD and NDVI) at booting, anthesis and grain filling stages, yield and yield attributes *viz.,*number of productive tillers per meter row, spike length (cm), number of grains per spike, number of spikelets per spike, harvest index, biomass and thousand-grain weight (g) were recorded under the study. The data obtained from two locations were subjected to the biometrical analysis that included heritability and genetic advance in percent mean. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad-sense heritability (h^2bs) and genetic advance over a mean (GAM) were estimated using formula suggested by Burton and De Vane (1953), Johnson *et al.* (1955) and Hanson *et al.* (1956).

Results and discussion

Among the cereals, wheat is moderately salt tolerant (Yadav *et al.,* 2011). Salinity is a major hazard to agricultural output

Table 1. List of genotypes used in the research programme

Sl No	Genotype	Sl No	Genotype	Sl No	Genotype	Sl No	Genotype
	Bread wheat		Durum wheat				
1	UAS BW-13892	33	UAS DW-31377	70	UAS DW-31408	106	DIC-72
2	UAS BW-13893	34	UAS DW-31378	71	UAS DW-31409	107	DIC-73
3	UAS BW-13894	35	UAS DW-31379	72	UAS DW-31410	108	DIC-74
4	UAS BW-13895	36	UAS DW-31380	73	UAS DW-31411	109	DIC-76
5	UAS BW-13896	37	UAS DW-31381	74	UAS DW-31412	110	DIC-77
6	UAS BW-13897	38	UAS DW-31382	75	UAS DW-31413	111	DIC-83
7	UAS BW-13898	39	GW 2015-689	76	UAS DW-31414	112	DIC-88
8	UAS BW-13899	40	UAS DW-31383	77	UAS DW-31415	113	DIC-91
9	UAS BW-13900	41	UAS DW-31384	78	UAS DW-31416	114	DIC-92
10	UAS BW-13901	42	GW-2010-284	79	UAS DW-31417	115	DIC-93
11	UAS BW-13902	43	GW 2014-550		Dicoccum wheat	116	DIC-94
12	UAS BW-13903	44	GW 2015-679	80	DIC-1	117	DIC-95
13	RAJ 4472	45	DBPY-2013-5	81	DIC-4	118	DIC-99
14	DR-18-07	46	UAS DW-31385	82	DIC-9	119	DIC-101
15	HPW-338	47	GW-2010-298	83	DIC-12	120	DIC-102
16	LBPY 2014-5	48	UAS DW-31386	84	DIC-13	121	DIC-103
17	RAJ 4478	49	UAS DW-31387	85	DIC-14	122	DIC-104
18	HD-2982	50	UAS DW-31388	86	DIC-15	123	DIC-105
19	HI1605	51	UAS DW-31389	87	DIC-17	124	DIC-106
20	PBW 373	52	UAS DW-31390	88	DIC-18	125	DIC-107
21	K-1412	53	UAS DW-31391	89	DIC-19	126	DDK 50033
22	GW2013-538	54	UAS DW-31392	90	DIC-21	127	DDK 50505
23	HD 3237	55	UAS DW-31393	91	DIC-22	128	DDK 50444
24	KA 1805	56	UAS DW-31394	92	DIC-23	129	DDK 50507
25	MP 3532	57	UAS DW-31395	93	DIC-26		Checks
26	JWS 810	58	UAS DW-31396	94	DIC-39	130	KRL 210 (salt tolerant)
27	9th HLBSN-12	59	UAS DW-31397	95	DIC-43	131	KRL 19 (salt tolerant)
28	UAS BW-13904	60	UAS DW-31398	96	DIC-44	132	UAS 304 (Bread wheat)
29	WH 1105	61	UAS DW-31399	97	DIC-45	133	UAS 334 (Bread wheat)
30	NIAW 3284	62	UAS DW-31400	98	DIC-46	134	UAS 428 (Durrum wheat)
31	PBW 550	63	UAS DW-31401	99	DIC-47	135	DDK 1029 (Dicoccum wheat)
32	UAS BW-13905	64	UAS DW-31402	100	DIC-48	136	HD 2009 (Bread wheat)
		65	UAS DW-31403	101	DIC-49	137	Kharchia 65 (Bread wheat)
		66	UAS DW-31404	102	DIC-50	138	KRL 99 (Bread wheat)
		67	UAS DW-31405	103	DIC-68	139	KRL 3-4 (Bread wheat)
		68	UAS DW-31406	104	DIC-70	140	IC 0408331 (Bread wheat)
		69	UAS DW-31407	105	DIC-71		

Table 2. Soil pH and Electrical conductivity of saline and control plot at different stages of crop

Crop stage	Soil layer	Saline		Control	
		pH	EC	pH	EC
Sowing	Top layer (0-20 cm)	8.01	6.56	8.02	2.89
	Bottom layer (20-40 cm)	7.98	6.51	8.01	3.01
Booting	Top layer (0-20 cm)	7.8	6.11	7.7	2.21
	Bottom layer (20-40 cm)	7.89	5.89	7.86	2.31
Grain filling	Top layer (0-20 cm)	8.02	6.02	7.95	3.32
	Bottom layer (20-40 cm)	7.77	6.11	7.99	3.11
Harvesting	Top layer (0-20 cm)	7.81	6.31	8.03	3.1
	Bottom layer (20-40 cm)	7.62	6.29	7.56	2.98

around the world, and it poses a significant threat to food security. Plant breeding aims to utilize genetic variability and diversity available in the *Triticum* species for various salt tolerance mechanisms, yield, and yield attributes. Plant breeding success is determined by the amount of variability in a crop. The ANOVA for the treatment mean sum of squares was significant for all the traits recorded under both saline and control condition (Table 3). The mean performance of grain yield varied from 16.23 q/ha and 31.21q/ha under saline and control conditions respectively, similarly mean performance of yield attributes *viz*., thousand grain weight varied from 30.10 g and 34.72 g, tillers per meter 77.00 and 107.00 and spike length

Table 3. ANOVA of wheat genotypes for different traits under saline and control conditions

Particulars	DF	SS		MSS		F		MEAN		SE		CV	
		Saline	Control	Saline	Control	Saline	Control	Saline	Control	Saline	Control	Saline	Control
GP	139	3278.77	1937.32	23.58*	13.93**	1.39	1.80	91.97	94.52	4.82	2.94	4.82	4.40
DFF	139	7520.27	7371.62	54.10 **	53.03 **	305.44	283.18	57.16	59.27	0.27	0.30	1.74	1.16
DM	139	9746.64	9746.64	70.11 **	70.11 **	390.69	390.69	106.91	107.91	0.29	0.29	1.39	1.25
PH	139	39651.73	26852.12	285.25**	193.18**	21.82	16.61	74.00	88.95	4.88	2.41	4.88	3.83
NDVI-I	139	3.34	1.93	0.02**	0.01*	13.66	1.41	0.58	0.644	0.29	0.07	5.35	5.38
NDVI-II	139	3.35	1.88	0.02**	0.01*	13.63	1.35	0.57	0.645	0.27	0.07	5.35	4.52
NDVI-III	139	2.54	2.53	0.01**	0.02**	1.51	1.51	0.60	0.591	0.77	0.07	6.08	3.54
SPAD-1	139	15178.54	7948.13	109.19**	57.18**	1.6	2.32	48.85	47.53	5.83	3.50	6.89	5.43
SPAD-II	139	5502.23	6818.64	39.58**	49.054**	1.77	2.14	39.77	44.91	3.33	3.38	5.85	4.65
SPAD-III	139	10253.76	6157.62	73.76**	44.29**	1.52	1.57	39.65	43.68	4.92	3.75	4.56	6.14
SL	139	564.49	673.64	4.06**	4.84**	4.57	25.04	5.89	8.3	15.98	0.31	13.98	5.29
SPS	139	16757.44	47624.21	120.55**	342.62**	45.81	127.86	24.26	29.56	6.68	1.15	6.68	5.53
GPS	139	11130.87	23482.77	80.07**	168.94**	18.97	41.03	26.02	33.67	7.89	1.43	7.89	6.02
TPM	139	247789.3	219462.9	1782.65**	1578.87**	107.45	68.92	77.00	107.00	5.29	3.38	5.29	4.44
TGW	139	5792.69	3120.81	41.67**	22.45**	200.68	31.70	30.1	34.57	1.51	0.59	1.51	2.43
BM	139	90857.55	240202.40	653.65**	1728.07**	11.60	7.59	73.8	102.02	2.22	2.63	9.00	14.78
HI	139	38815.45	38056.75	279.25**	273.78**	3.52	3.99	23.54	32.37	1.01	0.95	14.79	19.02
GY	139	11647.04	23871.10	83.79**	171.73**	29.45	323.02	16.23	31.21	0.54	0.78	10.38	8.33

GP- Germination percentage (per cent), DFF- Days to 50% flowering, DM-Days to maturity, PH- Plant height (cm), NDVI-I- NDVI before anthesis, NDVI-II- NDVI at anthesis, NDVI-III- NDVI at grain filling, SPAD-I- Chlorophyll content before anthesis, SPAD-II- Chlorophyll content at anthesis, SPAD-III-Chlorophyll content at grain filling stage, SL-Spike length (cm), SPS- Spikelets per spike, GPS- Grains per spike, TPM-Tillers per meter, TGW-Thousand grain weight (g), BM- Biomass (q/ha), HI- Harvest index, GY- Grain yield (q/ha), S- Saline, C- Control

Table 4. Genetic variability parameters for morpho-physiological traits in wheat genotypes grown under saline and control conditions

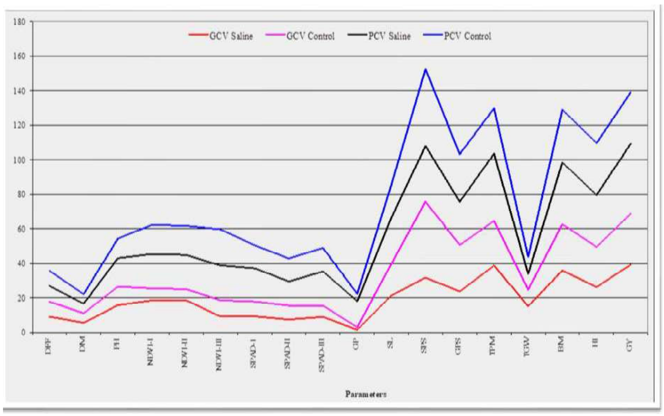
Characters	Mean		Range		GCV		PCV		h^2		GAM	
	S	C	S	C	S	C	S	C	S	C	S	C
GP	91.97	94.53	82.50-96.50	87.50-99.00	1.51	1.38	15.19	4.18	9.00	10.80	0.94	0.93
DFF	57.16	59.27	46.85-67.59	49.00-70.22	9.08	8.67	9.11	8.70	99.30	99.90	18.61	17.80
DM	106.91	107.96	92.50-119.01	94.50-119.11	5.51	5.53	5.54	5.54	99.50	99.20	11.36	11.36
PH	74.00	88.96	46.51-104.72	65.50-107.83	15.76	10.71	16.50	11.38	91.20	88.60	31.09	20.77
NDVI-I	0.58	0.64	0.31-0.84	0.40-0.76	18.49	6.99	19.90	16.90	86.40	17.10	35.40	5.96
NDVI-II	0.57	0.65	0.32-0.86	0.41-0.80	18.48	6.51	19.89	16.84	86.50	15.00	35.37	5.19
NDVI-III	0.60	0.59	0.40-0.83	0.38-0.81	9.14	9.43	20.26	20.81	29.80	20.50	8.49	8.80
SPAD-1	48.85	47.54	35.00-67.06	35.62-65.37	9.28	8.49	19.27	13.45	23.50	39.80	9.20	11.04
SPAD-II	39.77	44.91	31.55-50.45	34.70-55.45	7.40	8.05	13.98	13.36	28.00	36.40	8.07	10.00
SPAD-III	39.65	43.68	23.02-55.62	31.72-54.42	8.96	6.50	19.71	13.78	20.70	22.30	8.39	6.33
SL	5.89	8.31	3.00-11.50	5.55-12.28	21.36	18.36	26.68	19.11	64.10	92.30	35.22	36.35
SPS	24.26	29.57	9.50-49.00	11.00-74.50	31.64	44.09	32.34	44.44	95.60	98.40	63.78	90.12
GPS	26.02	33.67	9.50-40.50	16.00-71.00	23.66	26.96	24.95	27.63	90.00	95.20	46.25	54.20
TPM	77.00	107.00	23.00-175.00	42.50-175.50	38.61	25.93	38.97	26.31	98.20	97.10	78.81	52.64
TGW	30.10	34.57	19.73-43.22	23.18-44.30	15.12	9.54	9.20	9.84	99.00	93.90	31.00	19.04
BM	73.80	102.02	25.51-189.77	34.77-220.36	35.79	26.85	35.80	30.65	99.10	76.70	73.70	48.44
HI	23.54	32.37	5.64-46.83	10.83-50.58	26.19	23.30	30.08	30.08	75.80	60.00	46.98	37.17
GY	16.23	31.21	3.66-33.60	14.25-54.28	39.18	29.64	40.51	29.74	93.40	99.40	78.03	60.88

GP- Germination percentage (per cent), DFF- Days to 50% flowering, DM-Days to maturity, PH- Plant height (cm), NDVI-I- NDVI before anthesis, NDVI-II- NDVI at anthesis, NDVI-III- NDVI at grain filling, SPAD-I- Chlorophyll content before anthesis, SPAD-II- Chlorophyll content at anthesis, SPAD-III-Chlorophyll content at grain filling stage, SL-Spike length (cm), SPS- Spikelets per spike, GPS- Grains per spike, TPM-Tillers per meter, TGW-Thousand grain weight (g), BM- Biomass (q/ha), HI- Harvest index, GY- Grain yield (q/ha), S- Saline, C- Control

5.89 cm and 8.31 cm, under saline and control condition. Genetic information such as heritability and genetic advance over mean for various yield and yield contributing traits will be of great value to allow the breeder to use the best genetic stock to improve the breeding program (Kyosev and Desheva, 2015). It is interesting to note that germplasm exhibited wide variation for all the grain yield and agronomic traits indicating the existence of useful genetic variability among the entries studied.

Coefficient of variation

The range in mean values does not reflect the total variance in the material studied. Hence, the actual variance has to be



estimated for the characters to know the extent of existing variability. Hence, the coefficient of variation (PCV and GCV) which is calculated by considering the respective means have been used for the comparison (Table 4). High values of these parameters indicated wider variability and vice versa.The grain yield and other yield attributes *viz*., number of productive tillers per meter row length, biomass, spikelets per spike, thousand grain weight, grainsper spike and harvest index exhibited moderate to high PCV and low GCV indicating their high amenability for selection in advanced generations, under both saline and control condition. Similar findingswere reported by earlier workers like Dhonde *et al*. (2000), Sharma and Garg (2002); Dharmendraand Singh (2010) and Dashti *et al*. (2010).

The influence of the environment was significant on physiological traits like NDVI and SPAD and germination per cent as revealed by wider differences between PCV and GCV. These findings are following the findings of Mohammed *et al*. (2011) and Fellahi *et al.* (2013). Morphological traits like days to 50 per cent flowering, days to maturity and plant height were exhibiting low to moderate PCV and GCV under both saline and control condition, which indicates the higher influence of the environment in the expression of these traits was more. Similar observations were made by Ehdaie and Waines (1989), and Fellahi *et al*. (2013).Overall, the coefficient of variation indicated a moderate to high amount of variability for most of the traits.

Heritability and genetic advance over mean

Broad sense heritability gives an idea about observed variability attributable to genetic differences. According to Johnson *et al*. (1955), heritability estimates along with genetic gain would be more useful than the former alone in predicting the effectiveness of selecting the bestindividuals. Therefore, it is essential to consider the predicted genetic advance over mean along with heritability estimate as a tool in the selection program for better efficiency.

In the current study, under both saline and control condition,high heritability coupled with high genetic advance over mean was recorded fornumber of spike length, productive tillers per meter row length, biomass, spikelets per spike, grains per spike, thousand grain weight, harvest index and grain yield. This indicated that there was a low environmental influence on the expression of these characters and these attributes were extremely heritable. Hence, one can practice selection in early generations. High heritability coupled with moderate genetic advance was observed for a parameter like thousand grain weight. High heritability and genetic advance over mean for these traits were earlier reported by Uperti and Malik (2003); Gupta *et al.* (2004); Badole *et al*. (2010) and Dashti *et al*. (2010).

Low to moderate heritability and low to moderate genetic advance were noticed for important physiological traits like SPAD and NDVI, moderate to high heritability and GAM was reported for morphological traits like days to 50 per cent flowering, days to maturity and plant height,under both saline and control condition.Dhonde *et al*. (2000); Sharma and Garg (2002); Dharmendraand Singh (2010) and Dashti *et al*. (2010) reported similar results.

Conclusions

It is concluded from the present study that wheat germplasms can serve as the most potential donors for salt tolerance. Further, few promising accessions can be registered as national genetic stocks or identified as varieties. This is a kind of study, which indicates the possibility of exploration of the unrealized potential of wheat species to address the global issue of hunger and increasing population by wheat production in the unproductive saline soils.

References

Badole S S, Mukherjee S, Pal A K and De D K, 2010, Estimation of variability for yield parameters in bread wheat (*Triticum aestivum* L.) grown in Gangetic West Bengal. *Electronic Journal of Plant Breeding*, 1 (4): 764-768.

Burton G M and Devane E M, 1953, Estimating heritability in tall fescue from replication clonal material. *Agronomy Journal*, 45:478-481.

Dashti H, Naghavi M R and Tajabadipour A, 2010, Genetic analysis of salinity tolerance in a bread wheat cross, 12 (3):347-356.

Dharmendra S and Singh K N, 2010, Variability analysis for yield and yield attributes of bread wheat under salt affected condition. *Wheat Information Service*, 110: 35-39.

Dhonde S H, Kute N S, Kanawade D G and Sarode N D, 2000, Variability and characters association in wheat (*Triticum aestivum*). *Agriculture Science Digest*, 20 (2): 99-101.

Ehdaie B and Waines J G, 1989, Genetic variation, heritability and path-analysis in landraces of bread wheat from southwestern Iran. *Euphytica*, 41 (3): 183-190.

FAO, 2011, FAOSTAT (Food and Agriculture Organization of the United Nations: Rome, Italy). Available at http://faostat.fao.org/site/609

Fellahi Z E A , Hannachi A, Bouzerzour H and Boutekrabt A, 2013, Line × tester mating design analysis for grain yield and yield related traits in bread wheat (*Triticum aestivum* L.). *International Journal of Agronomy*, 2013.

Gupta R S, Singh R P and Tiwari D K, 2004, Analysis of heritability and genetic advance in bread wheat (*Triticum aestivum* L.). *Advances in Plant Sciences*, 17 (1): 303-305.

Hanson W D, Robinson H F and Comstock R E, 1956, Biometrical studies on yield in segregating population of Korean Lespedesa. *Agronomy Journal*, 48: 268-272.

Johnson H W, Robinson H F and Camstock R W, 1955, Estimates of genetic and environmental variability in Soybeans. *Journal of Agronomy,* (47):314-315.

Kyosev B and Desheva G, 2015, Study on variability, heritability, genetic advance and associations among characters in emmer wheat genotypes (*Triticum dicoccon* Schrank). *Journal of Bioscience and Biotechnology*, 221-228.

MoA&FW, 2018, Ministry of Agriculture and Farmers Welfare, Government of India. Available at: https://eands.dacnet.nic.in/Advance_Estimate/4th_Adv_Estimates2017-18_Eng.pdf

Mohammed A, Amsalu A and Bultosa G, 2011, Genetic variability, heritability and trait associations in durum wheat (*Triticum turgidum* L. var. *durum*) genotypes. *African Journal of Agricultural Research*. 6 (17): 3972-3979.

Mondal A K, Sharma R C, Singh G and Dagar J C, 2010, Computerised database on salt affected soils in India. Tech. Bull. 2/2010. CSSRI, Karnal.

Ramadas S, Kumar T K and Singh G P, 2019, Wheat production in India: Trends and prospects. Recent Advances in Grain Crops Research, pp. 1-37.

Rosegrant M W, Agcaoili-Somlilla N and Peret N, 1995, Global food projections to 2020. Discussion paper v. 5, IFPRI, WA.

Sharma A K and Garg D K, 2002, Genetic Variability in wheat (*Triticum aestivum* L) crosses under different normal and saline environment. *Annals of Agricultural Research,* 23: 497-499.

Sharma D K and Singh A, 2015, Salinity research in India- achievements challenges and future prospects. *Water Energy International*. 58 (6): 35-45.

Singh S, Sengar R S and Kulshreshta N, 2016, Differential response of selected bread wheat (*Triticum aestivum* L) genotypes for salt tolerance by using multiple parameters. *Journal of Wheat Research,* 8(1):19-24.

Uperti M C and Malik S K, 2003, Genetic variability heritability and genetic gain in bread wheat. *Journal of Agricultural and Biological Science,* 19(1): 15-21.

Yadav N M, Bagdi D L and Kakralya B L, 2011, Effect of salt stress on physiological biochemical growth and yield variables of wheat (*Triticum aestivum* L). *Agricultural Science Digest,* 31(4): 247-253.