Indian J. Genet., 69(4) (Spl. issue): 394-399 (2009)

Identification of high yielding, salt tolerant and stable genotypes of bread wheat (*Triticum aestivum* L.)

S. K. Yadav, R. S. Raje[1],* and S. R. Maloo[2]

Department of Plant Breeding and Genetics, SKN College of Agriculture, Jobner 303 329
[1]Division of Genetics, Indian Agricultural Research Institute, New Delhi 110 012
[2]Department of Plant Breeding and Genetics, R. C. A., Udaipur

Abstract

In the present investigation eighteen genotypes of wheat were evaluated under normal and saline soil environments over two years in *rabi* seasons in R.B.D. with two replications to study the g x e interaction and to identify stable genotypes. Pooled analysis of variance indicated significant variance due to genotype and g x e interaction for all the characters. Variance due to g x e (lin.) was significant for plant height, spikelets per ear, grain yield per ear, 1000-grain weight and grain yield per plant. The variance due to g x e (lin.) was higher than variance due to pooled deviation for all the characters except days to flowering. Environmental indices were higher under normal as compared to saline environments for all characters except for days to flowering. Out of eighteen genotypes, genotypes KRL 19, Job 673 and Kh 65 showed average response ($b \cong 1$) and were highly stable ($S^2_{di}= 0$). Out of these, the genotype KRL 19 had higher mean value than population mean, thus this genotype should be used in the hybridization programme. Genotypes Job 673 and Kh 65 should be used in hybridization programme and should be crossed with high yielding genotypes such as Raj 3077 to develop high yielding and stable genotypes. Genotypes KRL 20 and Job 666 showed above average stability with mean equivalent to population mean. Thus, these were suitable for high saline conditions. These genotypes should be crossed with high yielding genotypes like Raj 3077 to develop high yielding genotypes suitable for highly saline soils.

Key words: Wheat, g x e interaction, phenotypic stability, saline soil environment, normal soil environment

Introduction

Wheat (*Triticum aestivum* L.) is an important crop of the world rank first in area and production. Wheat is fairly tolerant to soil salinity [1]. About 954.834 million hectares of land throughout the world is affected by salinity and sodicity and this area is increasing year after year because of salt accumulation. In India substantial area (7 to 20 million hectare) is under salt affected soils [2]. According to IFPRI the demand for wheat is expected to grow by 1.3% per year world wide and 1.8% per year in developing countries during next 20 years [3]. Therefore, the wheat production will have to be increased but the current trends in genetic gain (little under % per year) in yield are too low to meet the future demand.

Environmental stresses are primarily responsible for limiting world food production while abiotic stresses are the main causes of yield reduction. Out of total world arable land only about 10% may be classified in a non-stress category while about 20% of land is limited by mineral stress, 26% by drought stress and 15% by freezing stress [4]. Development of genotypes tolerant to salinity is very important aspect for utilization of saline soils and saline irrigation water for growing crops.

Genetic complexity of the characters imparting salt tolerance hinders the breeding efforts directed towards combining higher yielding ability with salt tolerance. Moreover, the level of salinity varies considerably from one location to the other which again adds complexity to the problem. Thus, identification of higher yielding genotypes possessing stability of performance under different saline conditions and the information regarding genotype x environment interaction are two very important aspects in order to breed high yielding genotypes having stable performance over a range of saline soil conditions. In wheat, the information on these aspects is very scanty [5, 6]. Although, some studies regarding evaluation of genotypes under saline conditions have been conducted in wheat but most of them are confined to laboratory and micro-plot conditions, which do not simulate the natural saline

---

*Correspondence author's, e-mail: rajers@radifmail.com
Published by Indian Society of Genetics & Plant Breeding, F2, First Floor, NASC Complex, PB#11312, IARI, New Delhi 110 012
Online management by indianjournals.com

environments and also do not provide realistic results [7]. Therefore, present investigation was undertaken to identify high yielding genotypes with stable performance over saline soil and normal soil environments.

Materials and methods

Eighteen genotypes of wheat *viz*., HD 2285, HD 2329, HD 4530, Job 151, Job 666, Job 673, Job 983, Job 2028, Kh 65, KRL 1-4, KRL 19, KRL 20, Lok 1, Raj 3077, Sonalika, UP 2338, WH 157 and WH 542 were evaluated under normal and saline soil environments over two years in Randomized Block Design with two replications at Agriculture Research Farm, S.K.N. College of Agriculture, Jobner. For the saline environments the experimental material was evaluated under artificially created salinity nursery. Thus, there were four environments, two normal and two saline. The environmental characteristics (ECe and pH) have been presented in Table 1.

Table 1. Environmental characteristics

S.No.	Environments	Soil pH	Soil ECe (dSm^{-1})
1.	Saline (E_1)	8.2	7.9
2.	Normal (E_2)	7.6	1.2
3.	Saline (E_3)	8.3	8.8
4.	Normal (E_4)	7.9	0.9

In all the four environments, each genotype was sown in a two-row plot. Each plot consisted of two rows of 2.5-meter length. Row to row and plant-to-plant distance was kept 25 cm and 10 cm, respectively. All the recommended cultural and management practices were followed to raise a good uniform crop in all the four environments under irrigated condition. In all the four environments five randomly selected plants of each genotypes in each replication were evaluated for grain yield and its components. Mean values of five plants of each genotype in each replication were used for statistical analysis. However, data on days to flowering, days to maturity and 1000-grain weight were recorded on whole plant basis. Stability analysis for grain yield per plant and its component characters was carried out as per the model described by Eberhart and Russell [8].

Results and discussion

Analysis of variance (Table 2) indicated that variance due to genotype was significant for all the characters which indicated the presence of considerable amount of genetic variability. The significance of variance due to environment for most of the characters indicated that the environments were diverse. Furthermore, significance of g x e interaction for all the characters indicated variable performance of genotypes for all the characters over the environments. Similar findings were reported by Uma and Patil [5] and Singh and Chatrath [9].

Analysis of variance was also carried out as per the Eberhart and Russell's model (Table 3). The significance of variance due to g x e (lin.) for the characters plant height, spikelets per ear, grains per ear, grain yield per ear, 1000-grain weight and grain yield per plant indicated the presence of significant amount of predictable g x e interaction for these characters and also the possibility of prediction of the performance of the genotypes in different environments. Similar findings were reported by Singh and Rana [10] over normal and saline soils. However, significance of variance due to pooled deviation from regression for the characters plant height and days to flowering indicated that prediction of the response of the genotypes on the basis of regression analysis for these characters might not be reliable. Similar findings were also reported by Singh and Rana [10]. The higher magnitude of variance due to g x e (lin.) than the $\overline{S}^2$variance due to non-linear component indicated that the prediction of performance of the genotypes was possible. However, for days to maturity, ear length and tillers per plant variance due to g x e (lin.) was higher than that due to poled deviation.

The comparison of environmental indices (Table 4) indicated that for all the characters except days to flowering, the values of environmental indices were higher in the normal soil environments than that in the saline soil environments during both the crop seasons. The smaller values of environmental indices for E_1 and $E_{3,}$ which involved saline soil environments, than that for E_2 and E_4 clearly indicated that the salinity adversely affected all the component characters and ultimately grain yield per plant. In general, environments E_2 and E_4 were rich environments, which is obvious as they involved normal soil condition.

Various workers have used different measures for stability. Eberhart and Russell [8] emphasized the need of considering both linear (b_i) and non-linear ($_{di}$) components of g x e interactions in measuring stability of genotypes. Linear regression could be simply regarded as a measure of response of particular genotype whereas the deviation from regression ($_{di}$)

Table 2. Pooled analysis of variance for grain yield and its components

Source of variation	df	Plant height (cm)	Days to flowering	Days to maturity	Ear length (cm)	Spikelets per ear	Effective tillers per plant	Grains per ear	Grain yield per ear (g)	1000-grain weight (g)	Grain yield per plant (g)
Environments	3	410.708**	117.000**	32.250*	1.654	11.203*	4.346**	497.369**	1.542**	364.245**	85.758**
Replications	1	2.187	5.125	16.750	0.000	0.164	0.112	17.625	0.193	0.359	4.984
Replications x environments	3	6.708	3.375	4.583	0.254	4.207	3.459*	40.125	0.321	0.766	2.224
Genotypes	17	567.934**	136.463**	81.573**	8.191**	20.212**	3.475**	329.224**	0.469**	71.465**	24.109**
Genotype x environment	51	32.211**	16.532**	9.426**	0.705**	3.712**	0.965**	51.185**	0.119**	18.876**	6.106**
Error	68	2.958	2.342	5.176	0.352	1.297	0.297	19.416	0.042	3.926	1.268

*Significant at p = 0.05; **Significant at p = 0.01

Table 3. Joint regression analysis for grain yield and its components

Character	Genotypes	Environments	Genotype x environment	Genotype + (genotype x environment)	Environment (linear)	Genotype x environment (linear)	Pooled deviation	Pooled error
Plant height (cm)	283.955**	205.236**	16.111**	26.618**	616.012**	37.028**	5.331*	2.959
Days to flowering	68.232**	58.486**	8.267	11.057	175.455**	6.013	8.872**	2.341
Days to maturity	40.798**	16.129*	4.709	5.344	48.344**	5.703	3.979	5.178
Ear length (cm)	4.096**	0.826	0.353	0.379	2.481**	0.486	0.270	0.352
Spikelets per ear	10.106**	5.602**	1.856	2.064*	16.804**	2.433*	1.481	1.297
Effective tillers per plant	1.738**	2.173**	0.482*	0.576**	6.519**	0.499	0.443	0.297
Grains per ear	164.612**	248.679**	25.593	37.986**	746.047**	37.368*	18.610	19.416
Grain yield per ear (g)	0.235**	0.771**	0.059	0.099**	2.312**	0.096*	0.039	0.043
1000-grain weight (g)	35.733**	182.130**	9.438**	19.032**	546.368**	17.659**	5.032	3.926
Grain yield per plant (g)	12.054**	42.879**	3.053**	5.265**	128.637**	5.359**	1.794	1.267

*Significant at p = 0.05; **Significant at p = 0.01

as the measure of stability [11,12]. Thus, the genotype with lowest deviation around the regression line ($_{di}$ = 0) was considered to be the most stable and vice-versa. The mean performance was also considered along with above mentioned measures. Thus, in the present investigation *viz*., three measures mean, b_i and $_{di}$ = 0 were used to identify superior genotypes. Out of the eighteen genotypes, only one genotype i.e., KRL 19 was stable for grain yield ($_{di}$=0) with average response (b_i 1) (Table 5). This genotype was also having higher mean grain yield per plant than the population mean. Thus, this genotype is considered to be well adapted to all environments, normal as well as saline. Thus, this genotype should be used as one of the parents in hybridization programme to evolve high yielding and stable variety for cultivation in salt affected soils. Moreover, it was interesting to note that this genotype also showed average response (bi 1) and high stability ($_{di}$= 0) along with higher mean value than the population mean for other component characters such as effective tillers per plant, spikelets per ear and ear length. These were some of the characters which have been identified as major grain yield components in wheat. This genotype was also having average response, high stability and lower mean value than population mean for the plant height. Thus, it appeared that stability of this genotype for grain yield per plant was imparted by the stability for the yield components. Similar findings have been earlier reported [10,12].

Genotypes Job-673 and Kh 65 showed average response (b 1) and high stability ($_{di}$= 0) for grain yield per plant and these genotypes had mean grain yield per plant equivalent to population mean. Thus, these genotypes have characteristics for wider adaptability and can be grown under saline as well as normal environment. Similar findings for genotype Kh 65 have been earlier reported in bread wheat [13]. Although these genotypes did not give yield higher than population mean but these genotypes have potential to become get selected as parent in a hybridization programme aiming to develop genotypes with wider adaptability. These genotypes also showed average response (b 1) and high stability ($_{di}$= 0) for other characters such as days to flowering, days to maturity, ear length, spikelets per ear and 1000-grain weight. Thus, it can be concluded that the stability for grain yield of these genotypes was mainly due to stability for component characters. Singh and Rana [10] also reported low value of $_{di}$ and mean for the genotype Kh 65 along with lower values of b_i than unity, which indicated the poor response of this genotype to better environments. Another two genotypes *viz*., KRL 20 and Job 666 showed above average stability ($b_i < 1$ and S^2_{di}= 0) along with mean equivalent to population mean for grain yield per plant. Thus, these genotypes are suitable for cultivation under high salinity level because these have above average stability. It was interesting to note that KRL 20 had very small reduction in yield under saline environments whereas, Job 666 had substantially higher yield under salinity. Out of eighteen genotypes, only this single genotype i.e., Job 666 had higher grain yield under saline environments than that under normal environments. The above average stability of Job 666 for grain yield per plant was attributed by its above average stability for days to flowering, ear length and grains per ear. Similarly, above average stability of KRL 20 for grain yield per plant was mainly due to its above average stability for 1000-grain weight, grain yield per ear, grains per ear, ear length and days to maturity. These results again indicated that stability for grain yield per plant was mainly attributed by stability for grain yield components.

$\bar{S}^2$ Another genotype i.e., genotype Raj 3077 showed below average response (b_i>1 and S^2_{di}= 0) along with higher mean value than the population mean for grain

Table 4. Environmental indices for the environments

Character	Environments			
	E_1	E_2	E_3	E_4
Plant height (cm)	–2.5349	2.2409	–3.2249	3.5179
Days to flowering	1.1320	1.9376	–1.5624	–1.5069
Days to maturity	0.2712	0.6879	–1.3954	0.4379
Ear length (cm)	–0.1201	–0.0129	–0.1721	0.3060
Spikelets per ear	–0.5581	0.5402	–0.3973	0.4152
Effective tillers per plant	–0.3963	0.2193	–0.1782	0.3540
Grains per ear	–3.5547	1.4194	–2.4344	4.5683
Grain yield per ear (g)	–0.2120	0.1702	–0.1423	0.1854
1000-grain weight (g)	–2.5937	3.9311	–2.5764	1.2391
Grain yield per plant (g)	–1.6166	1.2298	–1.0199	1.4073

Table 5. Mean performance of genotypes over environments and stability parameters for grain yield and yield components

Genotype	Plant height (cm)			Days to flowering			Days to maturity			Ear length (cm)			Spikelets per ear		
		b_i	di		b_i	di		b_i	di		b_i	di		b_i	di
HD 2285	63.23**	3.10**	-0.91	79.88**	0.44	3.23	130.00	-0.14	-0.36	8.87	4.67	0.86	14.32*	5.38**	0.14
HD 2329	61.19**	1.82*	2.68	85.25	0.99	12.65**	125.88**	3.35	4.20	9.61	0.94	-0.15	15.14	1.85	-0.11
HD 4530	65.91**	-0.36*	7.30	87.88	0.96	0.65	131.00	0.76	5.13	6.07**	0.65	-0.14	13.90**	1.50	2.66
Job 151	74.98**	0.36**	-1.37	88.88	0.89**	-1.16	133.88**	0.49	-1.82	8.69	-0.65	0.05	15.48	-0.90**	-0.35
Job 666	74.42**	0.27	4.29	92.50**	0.45**	-0.91	131.12	-1.87	3.30	9.24	-1.59**	-0.09	15.95	-1.29	2.12
Job 673	79.39**	0.22**	-0.59	85.88	0.80	0.82	130.00	2.82	-0.30	9.38	0.01	0.13	14.18*	-0.97	0.28
Job 983	88.30**	0.94	4.85	91.88**	0.67	28.46**	134.25**	1.31	-1.27	9.00	3.20	0.15	14.64	1.50	2.18
Job 2028	74.83**	-0.09**	-0.93	90.88**	0.35	-0.17	134.62**	0.72	-0.69	10.16**	2.07	0.74	17.62*	0.83	-0.53
Kh 65	87.49**	0.37	12.92*	86.62	1.34	5.36	133.50**	1.37	-1.34	7.79**	0.16	0.29	14.27*	0.25	-0.51
KRL 1-4	65.72**	0.44	3.59	81.12**	0.42	12.81**	128.88	1.10	0.13	9.62	1.89	-0.07	16.90	1.12	0.18
KRL 19	61.77**	0.86	2.94	82.75	0.32	2.71	131.38	1.47	-1.40	10.20**	1.90	-0.05	19.33**	1.42	1.40
KRL 20	70.84	0.50	1.17	87.62	1.41	1.46	128.25	0.13**	-2.49	8.64	-2.50**	-0.15	16.52	0.15	4.51*
Lok 1	65.04**	0.63	3.14	82.38*	0.39	2.45	127.38*	-2.19	10.56	8.60	1.96	0.25	14.11*	1.16	0.39
Raj 3077	72.36	1.12	13.73**	86.12	1.44	0.38	125.38**	0.57	1.57	10.18**	-1.58	0.05	17.43*	-1.16	0.77
Sonalika	69.74	3.44**	1.98	80.00**	1.94	32.67**	123.00**	2.00	-1.72	9.61	3.34**	-0.17	15.40	2.67	0.03
UP 2338	64.23**	1.34	5.03	86.50	1.91	26.87**	131.62	1.85	0.41	10.27**	1.78	0.01	17.60*	0.68	0.52
WH 157	64.72**	0.81	1.91	79.75**	0.04	3.45	128.88	2.98	9.87	8.97	1.77	0.12	15.72	2.35	1.37
WH 542	60.36**	2.23*	7.59	59.75*	3.24*	6.90*	130.12	1.29	1.26	9.16	-0.05**	-0.15	17.82**	1.47	-0.06
Genotype	Plant height (cm)			Days to flowering			Days to maturity			Ear length (cm)			Spikelets per ear		
HD 2285	4.96	3.00*	0.19	41.77	1.40	-1.07	1.75	2.03**	-0.02	40.24*	1.38**	-1.91	8.22	2.25*	2.08
HD 2329	4.62	0.76	-0.03	44.09	2.29	8.71	1.76	2.82**	-0.01	37.65	2.11	5.57	7.41	1.76**	-0.32
HD 4530	3.22**	-0.73**	-0.03	31.50**	0.63	-7.85	1.28**	1.30	-0.02	39.57	1.41	2.04	3.67**	0.52**	-0.43
Job 151	3.44**	0.58	-0.11	37.28	0.79	-0.44	1.57	0.37	-0.01	42.00**	0.18	5.34	5.02*	0.48*	-0.22
Job 666	5.59*	-1.14	0.38	43.49	-1.01*	25.02	1.56	-0.14	0.06	35.78	0.72	4.07	8.50	-1.05**	2.47
Job 673	4.43	0.57	1.40**	35.69*	-0.28**	-7.99	1.39	-0.11*	0.01	37.03	0.63	5.45	5.77	0.17	2.80
Job 983	4.68	0.69	0.46	38.17	1.31	1.47	1.42	1.61	0.00	35.75	1.82**	-1.89	5.99	1.34	0.25
Job 2028	4.60	1.17	0.02	41.18	0.92	12.06	1.54	1.14	0.01	36.87	1.77*	-1.77	5.98	1.36	0.94
Kh 65	5.49	-0.44	0.68	37.44	-0.32**	-8.01	1.32*	0.13*	0.00	35.75	0.56	3.13	6.87	0.22	2.69
KRL 1-4	4.68	2.25	0.80*	43.61	2.21	22.62	1.67	0.93	0.09	38.19	0.11**	-0.28	7.53	0.92	6.75**
KRL 19	5.83**	0.51	0.47	61.17**	0.22	13.44	2.31**	-0.25	0.07	36.83	-0.41**	2.09	11.38**	0.94	-0.25
KRL 20	4.50	0.52	0.13	42.06	0.25**	-9.38	1.65	0.32*	-0.01	37.44	0.08*	3.29	5.87	0.14**	-0.39
Lok 1	4.41	0.62	0.52	37.65	1.19	-5.71	1.77	2.13**	-0.02	45.70**	1.76	3.08	6.83	1.63	2.28
Raj 3077	5.40	2.38	0.57	48.65**	2.00*	-1.76	1.87*	1.25	0.03	35.86	0.85	1.10	9.31**	2.03*	0.42
Sonalika	4.95	3.10*	0.13	39.13	1.52	13.52	1.64	1.58	0.10	37.68	2.46**	-1.76	7.80	2.45*	2.80
UP 2338	4.43	0.94	-0.05	41.58	2.11**	-4.72	1.47	1.45	-0.01	34.41*	1.10	13.17*	6.07	1.11	-0.47
WH 157	4.72	1.67	-0.06	38.27	1.01	10.54	1.38	0.51	0.00	36.03	0.73	-1.09	5.94	0.86	-0.47
WH 542	4.57	1.54	-0.09	47.59*	1.77	99.80**	1.50	0.93	0.06	32.26**	1.36	15.63*	6.86	0.85	-0.04

yield per plant and also for grains per ear. Thus, this genotype was more suitable for normal environments. Uma and Patil [5] also reported that this genotype was not suitable for saline soils. Genotype Raj 3077 showed average response (b 1), high stability ($_{di}$= 0) along with higher mean value than the population mean for characters grain yield per ear, spikelets per ear and ear length, while this genotype had lower mean value than population mean for days to maturity. Thus, this genotype should also be considered as highly stable genotype for these characters. Thus, this genotype has potential value as parent in hybridization programme due to its high stability for the grain yield per ear, spikelets per ear, ear length and days to maturity. Genotypes Job 2028 and UP 2338 also showed average response (b 1) and high stability ($_{di}$= 0) along with higher mean value than population mean for the characters ear length and spikelets per ear. Genotype UP 2338 also had average response (b 1), high stability ($_{di}$= 0) along with lower mean values than the population mean for plant height. Genotypes Job 151 and Lok 1 showed average response, high stability along with higher mean values than population mean for 1000-grain weight. Genotype Lok 1 also had average response, high stability and lower mean values than the population mean for the characters days to flowering and days to maturity. Another genotypes Job 666 showed average response (b 1), high stability ($_{di}$= 0) along with higher mean values than population mean for the character effective tillers per plant. Genotypes Job 666 and WH 542 showed above average response (b<1 and $_{di}$= 0) along with mean equivalent to population mean for the character ear length.

On the basis of stability analysis it can be concluded that the genotypes namely KRL 19, Job 673 and Kh 65 with wider adaptability have potential to be used in hybridization programme to develop widely adapted high yielding genotypes. Another two genotypes, KRL 20 and Job 666 with above average stability also showed the potential to be used as parents in hybridization programme to develop genotypes suitable for high level of salinity. Genotype Raj 3077 with below average stability has been found to be more suitable for better environmental conditions.

Genotypes KRL 20 and Job 666 should be crossed with high yielding genotypes such as Raj 3077 in the hybridization programme in order to recover superior recombinants with higher grain yield, above average stability (b_i<1) and ($_{di}$= 0) and also with more tolerance to high level of salinity. Moreover, genotypes Job 673 and Kh 65 should be crossed with high yielding genotype such as Raj 3077 in the hybridization programme in order to isolate genotypes with high yield and high stability along with average response. These superior recombinants will be suitable for a range of saline environments.

References

1. **Richards L. A.** 1954. Diagnosis and improvement of saline and alkali soils. USDA Hand Book No. **60**.
2. **Abrol I. P. and Bhumbla D. R.** 1971. World soil resources. FAO Report No. **41**: 42-45.
3. **Rosengrant M. W., Sombilla A. S. and Perez N. D.** 1995. Global food projections to 2020; Implications for investment. IFPRI, Washington, DC.
4. **Dudal R.** 1976. Inventory of major soils of the world with special reference to mineral stress hazards. In: Plant adaptation to mineral stress in problem soils, M. J. Weight (ed.), Cornell University. *Ithaca,* pp. 3-13.
5. **Uma M. S. and Patil S. G.** 1995. Yield performance of wheat genotypes in different saline environments. Madras Agric. J., **82**: 193-195.
6. **Ali Y., Aslam Z., Sarwar G. and Hussain F.** 2005. Genotypic and environmental interaction in advanced lines of wheat under salt-affected soils environment of Punjab. International J. Enviornmental Science and Technology, **2**: Autumn, 2005, pp. 223-228.
7. **Patil H. S., Manake B. S. and Chavan V. W.** 1992. G x E interaction for yield, 1000-grain weight and days to flowering in bread and durum wheat. J. Maharastra Agric. Univ., **17**: 440-442.
8. **Eberhart S. A. and Russell W. A.** 1966. Stability parameters for comparing varieties. Crop Sci., **6**: 36-40.
9. **Singh K. N. and Chatrath R.** 1995. Genotype x environmental interactions in some Indian rainfed varieties of bread wheat under salt stress conditions. Wheat Information Service, **8**: 6-11.
10. **Singh K. N. and Rana R. S.** 1984. Promising new wheat varieties for salt affected soils. Indian Farming, **27**: 20-21.
11. **Paroda R. S. and Hayes J. D.** 1971. Investigation of genotype x environment interaction for rate of ear emergence in spring barley. Heredity, **26**: 157-176.
12. **Jatsara D. S. and Paroda R. S.** 1980. Phenotypic adaptability of characters related to productivity in wheat cultivars. Indian J. Genet., **40**: 132-139.
13. **Muralia S.** 1993. Inheritance of salinity tolerance and its effect on yield in wheat (*T. aestivum* L. em. Thell.). Ph. D. Thesis, R.A.U., Bikaner, India (Unpublished).