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Research Article

Stability analysis for yield and quality traits in wheat (*Triticum aestivum* L.)

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Abstract
Experiment was conducted with eleven varieties of wheat for fourteen qualitative and quantitative traits in three date of sowing with 15 days interval *viz.*, 08th Nov. (Early sown as E_1), 23rdNov. (Normal sown as E_2), 08th Dec. (Late sown as E_3) during Rabi-2016-17 season at Experimental Farm of Department of Agricultural Botany, College of Agriculture, Latur, Maharashtra. Highly significant variations due to genotypes against pooled error revealed the presence of genetic variability for all the traits except yield per plant under study. The component G x E interaction being highly significant indicated that genotypes interacted considerably to environmental conditions in different environments. The predominance of linear component would help in predicting the performance of genotypes across environment. For yield per plant the genotypes, MACS-6222, PBN-3958 and GW-480 exhibited higher mean, bi near to unity and non-significant deviation from regression line, that genotype was stable under all environments. However, the genotypes MP-1323 for number of tillers per plant and harvest index (%), MACS-6222 for protein content (%) were stable over all environment. November 23rd normal sown was the most optimum time of sowing for wheat crop.

Key words
Wheat, stability analysis, G x E interaction, yield per plant.

Introduction

Wheat (*Triticum* spp.) is a most widely consumed cereal crop of the world in variety of forms. Global demand for wheat by the year 2020 is forecasted around 950 million tones. This target will be achieved only if global wheat production is increased by 2.5 % per annum. In India, 'Green revolution 'began with wheat crop in terms of total wheat production. The green revolution started from a mere 12.5 million tones in 1964 and has reached to 92.29 million tones during 2015-2016. This increase in wheat production provided food security to the country.

In India during 2015-2016 area under wheat cultivation was 30.47 million ha with the annual production of 92.29 million tones with an average productivity of 30.75 q/ha. In Maharashtra it occupies an area of 9.13 lakh ha with production of 14.0 lakh metric tones with an average productivity of 15.39 q/ha. In Marathwada region wheat is cultivated in an area of 169.8 thousand hectares with production of 138.3 thousand tones. Due to completion of irrigation projects like Purna and Jayakwadi in Marathwada region, the sufficient irrigation is available for the wheat crop but due to high temperature prevailing in the region yield of wheat was found to be low.

Terminal heat stress can be a problem in up to 40 percent of the irrigated wheat-growing areas in the developing world. (Reynolds et al. 2001). Studies conducted under controlled environments revealed that long hours of exposure to moderately high temperature as well as short exposure to very high temperature reduces the productivity substantially specially during flowering of wheat.

It is known that genotypes, environment and their interaction (G x E) have influence on the quality traits of wheat grain. Wheat quality is affected by environmental conditions such as temperature in the growing season, humidity during grain filling, duration of grain filling, sowing time and date.

Wheat varieties are grown in varied agro climatic conditions which cause fluctuations in yield and quality traits. So it is necessary to develop and identify phenotypically stable genotypes, which could perform consistently better over a wide range of environments. Besides categorization of varieties, it is essentials to identify the suitable genotypes for specific favourable and unfavourable environments for sustainable wheat production. The present investigation was undertaken to fulfill the objective to study the stability of different genotypes for yield and quality traits in wheat species.

Materials and Methods

The eleven genotypes of wheat including two checks were evaluated in RBD with 3 replications during rabi 2016-17 in experimental farm, Department of Agricultural Botany, College of Agriculture, Latur, Maharashtra. Data were recorded on 14 traits *viz.*, plant height, days to heading, days to 50 per cent flowering, days to maturity, number of tillers per plant, length of panicle, number of spikelets per panicle, number of grains per spikelet, number of grains per panicle, test weight, harvest index, protein content, gluten content and yield per plant. The data were collected and analyzed for analysis of variance, stability analysis, correlation and path analysis. The results obtained in three environments at 3 dates of sowing *i.e.* 08th November, 23rd November and 08th December. The analysis of variance for all the fourteen characters of eleven genotypes revealed significant differences among the genotypes studied over different environment, indicating sufficient amount of variability present among the characters. Environmental variances are found to be significant for all characters. G X E interaction also significant for all characters except days to heading. Data from the three environments and pooled data are subjected to Analysis of Variance (Panse and Sukhatme, 1967). The traits which showed the significant G x E interactions were subjected to stability analysis using the Eberhart and Russell (1966) model. As per the model, three parameters *viz.*, overall mean performance of each genotype across the environments, the regression of each genotype on the environmental index (i) and squared deviation from the regression (2di) were estimated. The significance of stability parameters and deviations from unity were tested by students test.

Results and Discussion

The three environments (3 dates of sowing *i.e.* 08th November, 23rd November and 08th December) showed significant differences for most of the characters This implies that there is a scope or possibility of selection of better genotypes in each group for most of the characters. Early environment (E1) (08th November) and normal environment (E2) (23rd November) produced significantly higher grain yield than late environment (E3) (22nd December) (Shirpurkar *et al*. 2006).

Stability analysis as per Eberhart and Russell (1966) model showed highly significant differences among genotypes for plant height, days to heading, days to 50% flowering, days to maturity, no. of tillers/ plant, length of panicle, number of spikelets per panicle, number of grains per spikelet, number of grains per panicle, test weight, harvest index, protein content, gluten content. The analysis of variance of variance for all the fourteen characters of eleven genotypes revealed significant differences among the genotypes studied over different environment, indicating sufficient amount of variability was present among character.

Variance due to Environment + (Genotype x Envir onment) was highly significant for all the trait when tested against pooled error. Genotype x Environment interaction is highly significant for all characters studied except days to heading when tested against pooled error. The regression analysis showed that the mean sum of square due to environment (Linear) was highly significant for all the trait when tested against pooled error, hence significant value for all the characters under study indicating that a major part of variation could be attributed to linear regression. Genotype x Environment (Linear) is significant for plant height, days to 50% flowering, length of panicle, no. of spikelets/panicle, no. of grains /spikelet, no. of grains /panicle, test weight, harvest index, protein content, gluten content when tested against pooled error indicates that the variation in the performance of genotype is due to the regression of genotypes on environments and hence the performance is predictable in nature. Mean square due to pooled deviation was found to be significant for all the characters except days to heading and days to 50% flowering, significant values indicating greater role of non-predictable components in genotype x environment interaction. Thus both linear and non-linear components were useful for determining the stability.

The studies on estimate of stability parameters revealed that none of the genotype was stable for all the characters. The genotypes PBN-3958, GW-480 and MACS-6222 for grain yield per plant, MP-1323 for number of tillers per plant and harvest index were stable characters which had showed ‘bi’ value close to unity (bi=1) and non-significant (s^2di) indicating its superiority for average response and stability over all environment whereas, UAS-379 was suitable for unfavourable environment for grain yield per plant. The results are in agreement with Gulzar *et al.* (2015), Thakare *et al.* (2014), Yadava R. (2003) who reported significance of both linear and non linear components and indicated the presence of both predictable and unpredictable components of G×E. Thakare *et al.* (2014) and Kashte (2013) has reported the predominance of linear and non linear components which are in agreement with the present findings.

Eberhart and Russell (1966) emphasized the need of considering both linear (bi) and non linear (S2di) components of G x E interaction in judging the stability of genotypes. An ideal genotype is defined as, one possessing high mean performance, with regression coefficient around unity (bi=1) and deviation from regression (S2di) close to zero.

On the basis of grain yield per plant three genotypes namely MACS-6222, PBN-3958 and GW-480 exhibited higher mean, ‘bi’ near to unity and non significant deviation from regression line, that genotype was stable under all environments. These genotypes which showed better grain yield over environment are GW-480 (11.26), MACS-6222 (10.76), PBN-3958 (10.75) respectively, and these three genotypes also exhibited regression coefficient values as GW-480 (0.83), MACS-6222 (1.02), PBN-3958 (1.20) and are non significant and further the deviation from regression values are also non significant. Here by indicating the highly stable performance of those genotypes for grain yield over the environments tested. Present findings are in close agreement with Anwar *et al.* (2007) Motamedi *et al.* (2012), Kant *et.al.* (2014), Thakare *et al.* (2015), Lodhi *et al.* (2015),

High yielding genotype GW-480 showed stability under all environments for the traits days to maturity and yield per plant where as for days to 50% flowering and harvest index it showed suitability under poor environment. The Second high yielding genotype MACS-6222 showed stability under all environments for the traits protein content and yield per plant where as for trait plant height, No. of grains per spikelet and gluten content it shows suitability under poor environment. The third high yielding genotype, PBN-3958 showed stability over all environments for the traits days to flowering, days to maturity and yield per plant where as, for the characters no. of tillers per plant, No. of grains per panicle it showed suitability under favourable environment.

Kashte (2013) and Thakare *et al*. (2014) performed stability analysis and reported that none of the genotype was stable for evaluated traits; however genotypes depicting stable performance for yield per plant, offered the possibilities of exploitation for varietal improvement program in *triticum* wheat. Since, segregates' combining high mean and stable performance could be expected in the advance generations.

Therefore, it is concluded that the genotypes GW-480, MACS-6222 and PBN-3958 could be included in the hybridization program to converge the stability characteristics of grain yield for the development of stable cultivar adapted to a wide range of environments. Thus any generalization regarding stability of genotypes for all characters it is too difficult since the genotypes may not simultaneously exhibit uniform responsiveness and stability for all the characters. While, the fourth genotype UAS-379 exhibited below average stable performance for yield per plant so it is suitable under for poor environment.

References

Arumugam, M., Rajanna, M.P. and Vidyachandra B. (2007). Stability of rice genotypes for yield and yield components over extended dates of sowing under Cauvery command area in Karnataka. *Zonal Agricultural Research Station.* **44** (2): 104-107.

Banerjee, J., Rawat, R. S. and Verma, J. S. (2006). Stability analysis in bread wheat *(Triticum aestivum* L. em. Thell) and durum wheat (*T. durum L.*) genotypes. *Indian J. of genetics.,* **66**(2): 145-146.

Bhullar, G. S., Singh, R. and Gill, K. S. (1983).Stability analysis in durum wheat. *Indian J.Genet*., **43**: 246-251.

Eberhart, S. A. and W. A. Russell, 1966. Stability parameters for comparing varieties, Crop. Sci. **6**:36-40

Gulzar, S., Kamaluddin, Bhatt, M. A., Yusuf, N. and Khan, M. A. (2015). Stability analysis for yield, yield component and quality traits in wheat (*Triticum aestivum* l.) under temperate conditions in kashmir valley. *Plant Archives.,* **15**: 433-440.

Kant, S., Lamba, R. A. S, Arya, R.K. and Panwar, I.S. (2014). Effect of terminal heat stress on stability of yield and quality parameters in bread wheat in south-west Haryana. *J. of Wheat Research*., **6**(1):64-73.

Kashte S. (2013) "Stability analysis for yield and quality traits in wheat" (*Triticum aestivum* L.) Thesis submitted to V.N.M.K.V. Parbhani.

Lodhi, R. D., Prasad, L. C., Bornare, S. S., Madakemohekar, A. H., And Prasad, R.(2015). Stability analysis of yield and its component traits of barley (hordeum vulgare l.) genotypes in multi-environment trials in the north eastern plains of india. *J. of Breeding and Genetics*., **47(**2): 143-159.

Motamedi, M., Naserierad, H., Naseri, R. and Soleymanifard, A. (2012). Assessment of genotype × environment interaction for grain yield in bread wheat genotypes. *Intl J. of Agri Crop Sci.*, **4**(18): 1366-1370.

Mut, Z., Aydin, N., Bayramoglu, H.O. and Ozcan, H. (2010). Stability of some quality traits in bread wheat (*Triticum aestivum L*). *J. of environmental Biology.,* **31**: 489-495.

Nagarajan, S., Tripathi, S., Singh, G. P. and Chaudhary, H. B. (2007). Effect of genotype and environment on quality traits and grain yield of wheat. *Indian J. Genet.,* **67**(2): 149-152.

Polat, P. O., Cifci, E. A. and Yagdi, K. (2016). Stability performance of bread wheat (*Triticum aestivum L.)* lines. *J. Agr. Sci. Tech.,***18**: 553-560.

Shirpurkar, G. N., Kashid, N. V. and Pisal, A. A. (2007). Effect of different sowing dates and varieties on yield and yield attribute of wheat. *Agric. Sci. Digest*., **27**(1): 68-70.

Thakare, S. D., Potdukhe, N. R. and Bharad, S. G (2014). Yield Stability over Sowing Windows in Wheat. *J. of pkv research.,* **38**(2): 30-36.

Verman, M., Jatav, S. K and Gautam, A.(2015). Phenotypic stability analysis over different sowing times in wheat. *Annals of Plant and Soil Research.,* **17**(3): 292-295.

Yadav, R. and Singh, T. B. (2003). Stability analysis in wheat for grain protein. *Indian J. of Genetics.,* **63**(4): 337-338.

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Table 1. Analysis of variance for stability in wheat

Sr. No	Character	Genotype	Env.+ (G X E.)	Environments	G X E	Environment (Linear)	G X E (Linear)	Pooled Deviation	Pooled Error	Total
	DF	10	22	2	20	1	10	11	60	32
1	**Plant height**	259.773** $^{++}$	28.455**	210.002** $^{++}$	10.3**	420.004** $^{++}$	6.606**	12.721 $^{++}$	1.398	100.742
2	**Days to Heading**	51.408** $^{++}$	10.077** $^{++}$	108.306** $^{++}$	0.255	216.613** $^{++}$	0.238	0.246	0.335	22.993
3	**Days to 50 % flowering**	52.306** $^{++}$	9.047** $^{++}$	91.284** $^{++}$	0.823*	182.568** $^{++}$	0.833*	0.74	0.409	22.566
4	**Days to Maturity**	59.609** $^{++}$	13.562** $^{++}$	136.036** $^{++}$	1.315**	272.071** $^{++}$	0.79	1.673 $^{++}$	0.387	27.952
5	**No. of Tiller/ plant**	0.749**	4.876** $^{+}$	43.71** $^{++}$	0.993**	87.421** $^{++}$	0.273	1.558 $^{++}$	0.11	3.587
6	**Length of Panicle**	1.154** $^{+}$	0.374**	0.6**	0.351**	1.199**	0.401**	0.274 $^{++}$	0.088	0.618
7	**No. of Spikelet/panicle**	5.785** $^{+}$	1.155**	1.461**	1.124**	2.921**	0.484**	1.604 $^{++}$	0.108	2.602
8	**No. of grains/ spikelet**	0.117**	0.088**	0.11**	0.085**	0.221**	0.036**	0.123 $^{++}$	0.013	0.097
9	**No. of grains/ panicle**	112.948** $^{++}$	25.579** $^{+}$	7.62*	27.375** $^{++}$	15.239*	47.618** $^{++}$	6.483 $^{++}$	2.216	52.882
10	**Test weight (1000 seed)**	41.874** $^{++}$	4.616**	5.549**	4.523**	11.098**	4.417**	4.208 $^{++}$	0.085	16.259
11	**Harvest Index (%)**	15.434**	8.976**	16.048**	8.269**	32.096**	7.562**	8.16 $^{++}$	1.028	10.994
12	**Protein Content (%)**	0.211**	0.102**	0.087**	0.104**	0.175**	0.082**	0.114 $^{++}$	0.004	0.136
13	**Gluten Content (%)**	2.648** $^{++}$	0.162**	0.147**	0.163**	0.294**	0.149**	0.162 $^{++}$	0.002	0.939
14	**Yield/ plant**	0.678	6.283** $^{+}$	53.82** $^{++}$	1.529**	107.639** $^{++}$	0.671	2.171 $^{++}$	0.347	4.531

***** and ****** indicates significant at 5% and 1%, against pooled error respectively.
+ and ++ indicates significant at 5% and 1%, against pooled deviation respectively.

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Table 2. Stability analysis for yield and yield contributing traits in wheat

Sr. No.	Genotype	Plant height			Days to 50% Flowering			Days to maturity		
		$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i
1	MP-1323	98.75	1.50	-0.06	65.11	1.10	-0.14	118.11	0.90	-0.07
2	GW-480	87.06	0.82	6.19*	60.77	0.74	0.72	113.11	0.90	-0.30
3	PBN-4818	107.46	1.13	4.39	56.77	1.32	0.91	108.66	0.90	-0.29
4	UAS-379	94.68	0.98	-0.18	65.33	0.71	1.93*	117.22	1.00	-0.37
5	CG-1021	97.13	1.27	-1.54	55.88	0.69	-0.27	108.22	0.85	1.11*
6	HI-1618	88.60	0.25	23.34**	55.66	0.88	0.79	108.22	0.76	-0.22
7	PBN-3958	120.33	1.29	62.12**	60.00	1.10	-0.35	113.00	0.90	-0.29
8	MP-3465	96.86	1.13	12.38**	66.33	0.93	-0.39	119.11	1.14	0.48
9	PBN-4888	90.88	0.36	6.91*	65.33	1.16	-0.38	119.11	1.27	0.94
10	MACS-6222©	97.15	0.79	2.53	62.00	1.28	-0.02	116.00	1.06	9.30**
11	NIAW-301©	100.21	1.49	6.71*	65.77	1.09	0.83	118.55	1.31	4.05**
	Grand mean	98.10			61.72			114.48		
	SE ±	0.7219			0.6853			0.6552		
	C.D.1%	2.9050			2.7578			2.6365		

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Table 2. Contd…

Sr. No.	Genotype	No. of tiller/plant			Length of panicle			No. of spikelet's/ panicle		
		$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i
1	MP-1323	6.66	1.02	-0.13	10.27	-3.59*	-0.08	18.48	0.56	0.20
2	GW-480	7.40	1.05	-0.08	9.04	1.68	0.01	17.95	-0.76	1.20**
3	PBN-4818	7.55	0.71	-0.05	8.46	1.49	-0.08	14.62	-0.53	0.45*
4	UAS-379	7.20	0.71	0.13	9.40	-0.50	0.04	17.04	3.10	-0.06
5	CG-1021	7.46	1.15	-0.13	8.97	1.94	-0.01	15.57	-0.10*	-0.11
6	HI-1618	8.33	1.12	0.84**	9.47	2.34	0.00	15.51	0.68	-0.11
7	PBN-3958	8.11	1.22*	-0.13	9.94	3.56	0.45*	18.15	3.27	2.41**
8	MP-3465	7.17	0.89	4.66**	10.00	1.69	-0.07	18.57	2.14	0.19
9	PBN-4888	8.08	1.14	3.31**	8.63	0.66	-0.04	17.88	1.23	1.64**
10	MACS-6222©	7.17	1.15	3.61**	8.90	2.07	-0.09	17.44	1.04	2.79**
11	NIAW-301©	7.22	0.82	3.64**	10.03	-0.33	1.91**	18.45	0.39	7.79**
	Grand mean	7.49			9.37			17.24		
	SE ±	0.384			0.238			0.221		
	C.D.1%	1.547			0.960			0.890		

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Table 2. Contd…

Sr. No.	Genotype	No. of grains/spikelet			No. of grains/panicle			Test weight (1000 seed)		
		$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i
1	MP-1323	3.10	0.74	0.18**	57.19	-7.43*	-1.66	42.15	1.08	2.82**
2	GW-480	2.85	-1.13	0.02	50.36	-1.04	0.99	39.71	1.10	1.50**
3	PBN-4818	2.74	2.11	0.03	39.02	7.66	14.39**	49.17	-0.47	2.85**
4	UAS-379	3.18	2.57	0.07*	52.70	-1.01	-1.69	36.25	2.14	2.24**
5	CG-1021	3.24	2.69	0.83**	48.36	10.50*	-2.03	45.97	-0.81	5.04**
6	HI-1618	2.78	1.82	0.01	43.42	2.97	8.64*	38.12	-1.23	2.80**
7	PBN-3958	2.96	0.53	0.06*	51.40	2.08	-1.93	38.37	-2.13	2.40**
8	MP-3465	2.84	1.66	0.04*	52.29	-1.19	0.37	43.11	4.65	23.40**
9	PBN-4888	3.07	-0.61	-0.01	55.31	7.10*	-2.05	39.31	0.65	0.20
10	MACS-6222©	3.03	-0.65	0.00	53.01	-0.72	30.49**	42.22	3.64	1.23**
11	NIAW-301©	3.35	1.27	-0.01	61.17	-7.94	3.13	40.76	2.37	0.89**
	Grand mean	3.01			51.29			41.38		
	SE ±	0.0982			0.6435			0.3251		
	C.D.1%	0.3950			2.5893			1.3082		

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Table 2. Contd…

Sr. No.	Genotype	Harvest Index (%)			Protein content (%)			Gluten content (%)			Yield/plant		
		$\bar{X}$	b_i	S^2d_i	$\bar{X}$	b_i	S^2d_i	$\bar{X}$	b_i	S^2d_i	$\bar{X}$	b_i	S^2d_i
1	MP-1323	43.95	0.73	-1.08	10.98	0.87	0.02*	6.51	6.12	0.64**	10.88	1.08	2.04*
2	GW-480	44.52	-0.76	-0.67	10.84	0.89	0.05**	6.14	0.43	0.01	11.26	0.83	-0.34
3	PBN-4818	38.61	0.91	13.47**	11.55	-1.27	0.01	7.27	2.74	0.51**	9.75	0.75	4.04**
4	UAS-379	42.98	-0.65	1.01	11.41	3.36	0.24**	6.24	-1.55	0.15**	10.57	0.55	0.25
5	CG-1021	41.28	4.21	7.53**	11.49	-1.48	0.06**	5.86	-1.78	0.14**	10.37	0.93	-0.36
6	HI-1618	39.67	0.89	18.07**	11.70	1.29	0.07**	6.29	-0.08	0.00	9.84	1.46	0.20
7	PBN-3958	37.49	-0.48	23.03**	11.25	-2.60	0.18**	6.73	0.20	0.00	10.75	1.20	1.18
8	MP-3465	41.95	2.01	-1.05	11.37	4.51	0.59**	9.27	3.72	0.31**	10.86	1.25	6.61**
9	PBN-4888	40.01	1.84	4.88*	11.06	4.05	0.00	7.20	-0.45	0.00	10.16	1.15	4.69**
10	MACS-6222©	42.64	-0.54	12.48**	11.52	1.04	0.00	7.41	0.32	0.00	10.76	1.02	0.86
11	NIAW-301©	39.51	2.84	0.11	11.34	0.35	0.01	7.18	1.34	0.01*	10.13	0.78	0.33
	Grand mean	41.15			11.32			6.92			10.49		
	SE ±	1.2129			0.0818			0.0398			0.8022		
	C.D.1%	4.8806			0.3292			0.1601			3.2281		