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PHENOTYPIC STABILITY ANALYSIS OVER DIFFERENT SOWING TIMES IN WHEAT

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ABSTRACT

Sixteen bread wheat and two durum wheat genotypes was evaluated under irrigated environment during the rabi season of 2011-12.The analysis of variance revealed that mean squares sources were significant for genotypes and genotype x environment for all the traits studied except harvest index. The linear components of G x E interactions were significant for all the traits except days to heading, 1000-grain weight, harvest index and grains ear^{-1}. Stability Parameter σ^2_{di} was found non-significant for traits viz., days to heading, days to flowering, ear length and grain ear^{-1}, thus, all varieties are stable in the expression for these traits. Unit regression coefficient 'b$_i$' revealed that variety GW 273 showed predictable linear performance for grain yield; GW 190 and HI 8498 for 1000 grain weight; GW 322 and GW 173 for biological yield; GW 366, HI 8498 and MP 4010 for days to heading, PBW 343 for days to maturity, GW 366, GW 273, HD 2932 and PBW 343 for plant height, HI 1544, GW322, GW 190, HD 2930 and DL 788-2 for tillers plant^{-1}, GW 273, GW 190 and HI 8627 for ear length, 11 varieties for harvest index and 7 varieties for seed ear^{-1}. Non-significant deviation from regression and regression coefficient indicated that GW 273 showed high mean performance, average responsive and stable for grain yield, biological yield, plant height and ear length and only stable for 1000 grain weight, days to heading and maturity and ear length. LOK 1 and HI 8627 was responsive in late sown and stable for grain yield, biological yield, harvest index, tillers plant^{-1} and seed ear^{-1}. Genotypes GW 273, GW190, and HI 8627 which recorded good yield and possessed wider adaptability thus may be exploited for grain yield and more components, HI 8381, HI 8627 and HD 2930 for harvest index and other components for timely sown conditions, HI 8498, RVW 4106, SUJATA for biological yield and 1000 grain weight. Most of the varieties are released for central zone either for timely or late sown conditions had stability attributes for one or more yield attributes.

Key words: Wheat, stability analysis, regression coefficients and yield

INTRODUCTION

In Madhya Pradesh, wheat is grown in around 5.79 million hectares with a production of 13.92 million tones and productivity was around 2.40 m t/ha during 2013-14 (Anonymous, 2014). Although there are number of varieties released in central zone for timely or late sown condition, the area and production showed more or less stagnant situation in this decade. Another quantum jump in wheat production is almost necessary to meet out the ever increasing food requirement for domestic consumption and for earning foreign exchange also. Stability in crop production is important for the plant breeders as well as for the planners to recommend a variety to the farmers and plan for national needs. An identification of stable varieties over range of time of sowings is the only way to bring more area under cultivation and increase the productivity of the wheat in different situations of central zone of India. Thus, present investigation could lead the identification of superior genotypes on the basis of stability parameters and could be valuable for more appropriate adaptation of wheat varieties for wider planting period to cover larger area under central India. The aim of this paper was to study the performance of *aestivum* as well as *durum* wheat varieties under different sowing environments and relative stability of different characters under different sowing dates.

MATERIAL AND METHODS

The material for the study consisted of 18 wheat varieties, out of these 16 bread wheat (*Triticum aestivum*) and 2 *Durum* varieties (*Triticum durum)* (Table 2 a&b). The experiments were conducted in randomized block design with two replications in 6 sowing dates irrigated environments during the *rabi* season of 2011-12 at Gwalior. Sowing dates were 2 timely sown on 17 and 28 November, 2011 (E1 and E2); 2 late sown on 11 and 21 December, 2011 (E3 and E4) and very late sown on 7 and 17 January 2012 (E5 and E6). Gwalior is situated at an altitude of 211.52 MSL, 26^0 13' N Latitude and 78^0 14' E Longitude. The soil is sandy loam, low in available nitrogen, medium in phosphorus and high in potash with pH of 8.5. The plot size for each genotype was two rows of 5 m length with row to row spacing of 23 cm. The recommended seed rate of 100 kg ha^{-1} was applied in each sowing environment. The observations were recorded on five randomly selected plants from each plot for yield and its attributes *viz*., days to heading, days to maturity, plant height,

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number of tillers plant^{-1}, ear length, grain ear^{-1}, 1000 grain weight, grain yield plant^{-1} and biological yield plant^{-1}. The stability analysis was done by using model of Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The stability analysis of variances revealed in experiment that mean squares due to wheat varieties (G) and sowing environments (E) were significant for almost all the traits (Table 1), thereby, suggesting diversity for varieties and environments. Interaction of G X E was significant for grain yield, day to maturity, biological yield, plant height, tillers plant^{-1} and ear length and thus performance of a variety cannot be predicted for these traits over fluctuating environments. The G X E (linear) interaction and pooled deviation mean squares were also significant for all the traits except days to heading and grain ear^{-1}, thereby, indicating the presence of both predictable and non-predictable components of G X E interaction in the expression of these traits. It was revealed that both linear and non-linear sensitivity components were essential for the expression of these traits. However, linear portion of G X E interaction was higher than that of non-linear portions. Present results are in agreement with those of earlier reports of Koumber *et al.* (2011), Klc and Yagbasanlar (2010).

Table 1: Pooled analysis of variances for grain yield and its components in wheat

Source of variation	D.F	Mean sum of squares								
		Grain yield (gm)	**Biological Yield**	**Days to heading**	**Day to maturity**	**1000 grain weight (gm)**	**Plant height (cm)**	**Tillers / plant**	**Ear length**	**Grain / ear**
Varieties (G)	17	38.56*	202.99*	34.04**	7.73**	53.41**	492.23**	0.62**	7.12**	120.27**
G X E	107	137.74**	508.98**	25.21**	116.25**	55.17**	139.83**	0.69*	1.78**	37.91
E+(V X E)	90	156.47**	566.78**	23.54**	136.75**	55.50**	73.27**	0.70**	0.77	22.350
E(Linear)	1	10870.29**	38138**	1872**	12116**	3750.2**	4886.64**	32.65**	24.06**	499.30**
V X E (linear)	17	59.16**	373.66**	3.03	4.52**	21.63	45.56**	0.65*	1.00**	20.62
Pooled Deviation	72	30.64**	90.55**	2.72**	1.60**	12.18**	12.95**	0.26**	0.39**	16.14**
Pooled Error	108	9.51	66.56	4.46	1.47	8.63	14.29	0.24	0.49	27.20

** and ** significant at 5 and 1% probability levels, respectively*

Stability parameters revealed that GW-273 showed significantly higher grain yield/ plant (30.20g) and its performance was predictable and stable in varying dates of sowing as revealed by corresponding unit regression coefficients and non-significant deviation from unit regression coefficient. Thus GW-273 may be commercially exploited in larger area of its adaptation. This variety also showed unit regression coefficients and non-significant S^2d_i value for biological yield, ear length, plant height which may be attributed in yield stability parameters. Jena *et al.* (2005) and Peterson *et al.* (1992) suggested that the regression coefficient was a measure of response to varying environments.

Table 2a: Stability parameters for grain yield and its components in wheat

Varieties	Grain yield (g)			Biological yield (g)			Days to heading			Days to maturity			1000 gain weight (g)		
	Mean	**b_i**	**S^2d_i**	**Mean**	**b_i**	**S^2d_i**	**Mean**	**bi**	**S2di**	**Mean**	**bi**	**S2di**	**Mean**	**b_i**	**S^2d_i**
HI-1544	29.55	0.85**	43.94**	79.83	0.79**	160.3*	71.42	0.96**	-0.28	109.0	0.99**	1.90	38.9	1.056**	6.61
DL-803-3	26.80	0.52**	24.79**	67.58	0.34**	20.4	69.58	0.85**	3.83	107.9	1.05**	0.50	33.8	1.196	3.66
LOK-1	28.80	0.83**	8.30	72.83	0.93**	34.2	70.42	1.12**	2.30	108.9	1.08**	1.45	40.8	1.204*	24.71*
GW-366	31.09	0.94*	22.32*	76.75	0.86**	104.4	72.67	1.00	-0.93	109.0	0.92**	0.76	37.1	1.145**	40.14**
GW-322	31.12	1.15**	27.47**	73.50	1.04	51.1	73.58	1.21**	5.40	109.1	1.09**	-0.11	35.9	0.855*	15.53
GW-273	30.20	1.12	3.01	74.75	1.10	12.4	73.42	1.03*	-0.65	108.3	1.08**	0.27	38.3	1.584**	10.41
GW-173	24.48	0.44**	0.15	60.00	0.24**	82.7	67.25	0.62**	6.14	106.3	0.99**	0.06	37.4	0.734**	-0.66
GW-190	31.33	1.15**	16.80	69.25	1.17**	-6.4	74.67	1.14**	-1.12	108.4	1.03**	0.64	31.6	1.061	7.98
HI-8498	29.68	1.39**	69.37**	71.83	1.35**	35.0	73.25	0.99	-0.87	109.4	1.04**	0.54	43.8	1.344	6.93
RVW 4106	29.45	1.45**	45.24**	79.92	1.79**	40.0	74.50	1.32**	1.51	108.6	1.12**	1.09	35.2	0.69**	14.26
SUJATA	29.25	1.46**	36.11**	82.17	1.49**	183.4*	75.08	1.23**	3.32	110.8	1.10**	2.92	36.9	0.385**	9.18
HI-8627	29.19	0.64**	4.97	78.67	0.75**	103.4	75.42	1.07**	2.74	109.8	0.95**	1.88	39.1	0.679**	5.15
HD-2932	27.01	0.70**	51.61**	76.17	0.25**	149.9*	74.17	0.88**	-0.83	109.7	0.97**	1.37	36.7	0.994	1.45
DH-2930	31.28	1.21**	50.62**	75.08	1.28**	63.4	73.75	0.92**	-0.22	108.8	0.88**	0.80	35.8	0.716**	-0.36
DL-788-2	26.13	0.89**	25.60*	79.08	0.89**	46.7	69.75	0.93**	1.12	108.3	0.92**	2.85	37.6	1.608**	22.44*
PBW-343	28.75	1.15**	26.56*	74.25	1.23**	72.1	76.17	0.95**	4.73	111.3	1.00	1.73	34.5	1.084**	3.45
MP4010	29.57	0.80**	22.15*	76.83	1.18**	90.1	74.75	1.02	1.52	109.8	0.82**	0.60	40.0	0.746**	-1.12
HI-8381	36.27	1.33**	27.21*	85.42	1.32**	69.8	71.83	0.76**	0.02	110.5	0.96**	2.46	41.9	0.92**	8.36
Mean	29.44			75.22			72.87			109.1			37.5		
SE(m±)	3.17		9.51	8.39		66.56	2.17		4.46	1.2		1.472	3.0		8.63
CD .5%	6.46			17.09			4.43			2.5				6.2	
CV%	10.78			11.16			2.98			1.1				8.1	

The genotype GW-190 possessed higher grain yield (31.33g) and showed significant regression coefficients over unit regression (b=1.15**) and had non-significant S^2d_i value, hence, could be stable but may be only recommended for favourable sowing environments. GW-190 also showed unit regression coefficients and non-significant S^2d_i values for 1000 grain weight, harvest index, reproductive period, tiller plant^{-1}, ear length and seeds ear^{-1} indicating that these traits may be attributed in yield stability parameters in favourable direction. GW-366, MP-4010, HI-1544, DL 803-3 and DL-788-2 recorded higher grain yield but showed significantly low regression coefficient from unity along with significant S^2d_i values, thereby, indicating that these varieties were superior for grain yield but unstable in performance and noticed to be suitable for poor environments but not stable.

Unit regression coefficient was recorded by GW 190 and HI 8498 for 1000 grain weight; GW 322 and GW 173 for biological yield; GW 366, HI 8498 and MP 4010 for days to heading, PBW 343 for days to maturity, GW 366, GW 273, HD 2932 and PBW 343 for plant height, HI 1544, GW322, GW 190, HD 2930 and DL 788-2 for tillers per plant, GW 273, GW 190 and HI 8627 for ear length, HI-1544, GW-366, GW-273, GW-173, GW-190, HI-8489, RVW-4106, SUJATA, DH-2930, DL-288-2 and HI-8381 varieties for harvest index and HI-1544, GW-322, GW-173, GW-190, HD-2932, MP-4010 and HI-8381 varieties for seed ear^{-1}, thereby, indicating all these genotypes were average responsive for respective traits over varying dates of sowings (Table 2b). Thus these varieties are showing increasing trend of cultivation and recognised in the area and high production levels in the central India over years.

Table 2b: Pooled analysis of variances for growth and yield attributes character in wheat

Varieties	Plant height (cm)			Tillers / plant			Ear length (cm)			Grain / ear		
	Mean	bi	S2di	Mean	bi	S2di	Mean	b_i	S^2d_i	Mean	bi	S2di
HI-1544	88.95	1.33**	2.73	3.83	0.90	0.15	9.42	0.46**	-0.02	42.83	0.99	3.8
DL-803-3	89.05	1.29**	1.21	3.75	0.37**	0.22	9.07	0.68**	-0.03	43.50	1.12	5.8
LOK-1	88.66	1.27**	2.94	4.50	0.47**	-0.04	8.15	1.69**	0.154	32.25	-0.14*	31.1
GW-366	91.50	0.96	-1.13	3.92	0.25**	0.09	7.90	-0.49**	-0.01	40.67	1.04	2.7
GW-322	88.17	1.16**	4.28	3.92	0.97	0.06	8.87	1.66**	0.632	43.50	-0.29	17.0
GW-273	94.83	0.96	3.22	3.58	0.30**	0.07	9.73	1.12	0.11	52.67	2.54*	9.5
GW-173	76.47	0.74**	5.73	3.75	0.32**	0.36	7.92	0.7*	0.256	39.33	0.87	3.3
GW-190	92.42	1.06*	2.24	3.50	0.91	0.19	9.22	1.07	0.016	47.33	1.63	15.3
HI-8498	83.93	0.61**	5.87	3.08	1.32**	0.20	5.98	2.25**	0.078	42.75	0.87	-3.7
RVW4106	92.82	1.17**	3.21	4.00	2.29**	0.44	10.17	2.73**	0.339	45.25	-0.08*	15.7
SUJATA	121.05	2.25**	76.64	4.17	1.48**	0.41	8.20	1.77**	0.594	40.00	2.5**	1.4
HI-8627	92.32	0.56**	5.99	3.50	0.58**	0.41	6.93	0.9	-0.07	43.92	1.45*	20.2
HD-2932	90.27	1.04	6.72	4.08	1.62**	0.05	8.62	0.5**	0.664	45.00	1.3	0.4
DH-2930	93.36	0.52**	-2.48	3.75	0.90	0.16	8.74	1.39**	0.297	44.08	1.94*	2.7
DL-788-2	84.15	0.87**	14.01	3.92	1.03	0.00	8.02	0.44**	0.057	38.50	1.08	-2.6
PBW-343	86.98	1.00	11.68	4.17	2.02**	0.55*	8.40	0.17**	0.635	38.83	-0.47**	0.5
MP4010	83.92	0.57**	8.20	4.08	1.51**	0.21	6.55	1.48**	0.254	42.75	0.65	10.2
HI-8381	81.82	0.64**	14.01	4.08	0.76**	0.10	7.52	-0.53**	0.703	36.08	0.98	27.5
Mean	90.04			3.87			8.30			42.18		
SE(m±)	3.89		14.3	0.50		0.236	0.72		0.493	5.37		27.20
CD .5%	7.92			1.02			1.47			10.93		
CV%	4.32			12.94			8.71			12.72		

, significant at 5% and 1% level of significance, respectively*

The genotypes LOK 1 and HI 8627 responsive in late sown and stable for grain yield, biological yield, harvest index, tillers plant^{-1} and seed ear^{-1} as suggested by significant regression coefficients form unit regression and had non-significant S^2d_i values, hence, could be stable but may be only recommended for favourable late sowing environments. Stability analysis for yield attributing traits revealed that GW-173(37.4), MP-4010 (40.0) and HD-2930 (35.8) possessed high mean values for 1000 grain weight and significant regression coefficients approaching unity and non-significant deviations from regression coefficient, hence, these were stable but responsive in poor environments may be suitable for late sowing environments. The genotype HD-2932 had high 1000 grain weight (36.7g) with unit regression coefficient (bi=0.994) and non-significant deviation from regression, thereby indicating stable and average seed size and suitable for wide sowing of environments (Table 2b).

Genotypes GW 273, GW190, and HI 8627 recorded significantly higher yields and possessed wider adaptability thus may be exploited for grain yield and more components HI 8381, HI 8627 and HD 2930 for harvest index and other components for timely sown conditions, HI 8498, RVW 4106, SUJATA for biological yield and 1000 grain weight. Most of the varieties are released for central zone either for timely or late sown conditions have stability attributes for one or more yield attributes.

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