Original Research Article

Genetic Variability, Heritability and Genetic Advance Analysis in Bread Wheat (*Triticumaestivum* L.) Genotypes

ABSTRACT

Forty diverse wheat genotypes were evaluated for genetic variability, heritability, and genetic advance at the Research Farm of Kisan (PG) College, Simbhaoli, Hapur (U.P.) during *rabi* season 2021-22. The genotypes were grown in randomized block design with three replications and data were collected on eleven morphological characters. Analysis of variance had shown highly significant differences among the genotypes for all the characters under study, indicated availability of wide range of variability among the genotypes. Higher values of PCV and GCV were recorded for grain yield/plant, harvest index, tillers/plant and biological yield/plant. Heritability estimates were highest for 1000 grains weight followed by days to heading, grain yield/plant and plant height. The estimates of genetic advance (GA) were highest for grain yield/plant, harvest index and biological yield/plant. High heritability along with high genetic advance (per cent of mean) was observed for grain yield/plant, harvest index and biological yield/plant which suggested that selection for these characters would be more effective for desired genetic improvement.

KEYWORDS: *Bread wheat, genetic variability, GCV, PCV, heritability, genetic advance.*

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) of family Poaceae is the second most important staple food crop of the world after rice. It is a self-pollinated crop originated from South West Asia. Wheat is considered as king of cereals accounting for 20% of human consumption of calories. *Triticum aestivum*, *Triticumdurum* and *Triticumdicoccum*species of wheat are presently grown as commercial crop in India. In India wheat occupies an area of 31.05 million hectare with production of about 107.18 million tons during 2019-20 (Anonymous, 2020). The major wheat producing states are Uttar Pradesh,Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra, Gujrat, Karnataka, West Bengal, Uttarakhand, Himachal Pradesh and Jammu and Kashmir contributing about 99.5 per cent of total wheat production in the country. Uttar Pradesh is the largest wheat producing state in India and accounts for 33.97% of total area under wheat cultivation in India.

The magnitude of genetic variability present in a population is essential for the success of crop improvement program. The development of an effective plant breeding program is dependent upon the existence of genetic variability present in the plant population. Hence, the amount of variability present in the gene pool of a crop species is of prime importance to a plant breeder for starting a judicious plant breeding program (Farshadfar*et al*., 2013). Heritability and genetic advance are important selection parameters. The estimates of heritability along with genetic advance are helpful in predicting the gain under selection. Heritability is a measure of the phenotypic variance attributable to genetic causes and has predictive function in breeding crops (Songsri*et al*., 2008). High heritability coupled with high genetic advance reveals strong contribution of additive genetic variance for expression of the traits and the selection based on these traits could play a vital role in improving grain yield (Iqbal and Khan, 2003). The estimation of heritability helps the plant breeder in selection of elite genotypes from diverse genetic populations. Hence, the present investigation was carried out to estimate the genetic variability, heritability and genetic advance which can be further used in breeding and crop improvement programme.

2. MATERIAL AND METHODS

2.1. Experimental site and experimental design

The present investigation was carried out at Research farm of Kisan (PG) College Simbhaoli, Hapur (U.P) during *rabi* 2021-22 under normal irrigation condition. Forty genotypes of bread wheat were taken for study obtained from Indian Institute of Wheat and Barley Research Karnal, Haryana. The experiment was laid in a randomized block design with three replications. In each replication, each genotype was grown in single row of 3m length with row to row and plant spacing of 25cm and 10cm respectively. All the recommended agronomic practices were followed to raise a healthy crop.

2.2. Characters studied

The data were recorded from five randomly selected plants from each genotype on eleven distinct morphological characters *viz*., days to heading, days to maturity, plant height (cm), number of effective tillers/plants, spike length (cm), number of spikelets/spikes, number of grains/spike, 1000-grain weight (g), grain yield/plant (g), biological yield/plant (g) and harvest index (%).

2.3. Statistical analysis

Standard statistical procedure was used for the analysis of variance, genotypic and phenotypic coefficient of variation, heritability, and genetic advance.

3. RESULTS AND DISCUSSION

3.1 Analysis of variance

ANOVA of all the characters under study was represented in Table 1. The analysis of variance revealed highly significant differences among the genotypes thereby indicating presence of considerable amount of genetic variability for all the eleven characters. Significant differences among the genotypes for different traits were also earlier reported by Singh *et al*., (2014), Kumar *etal*., (2016) and Vaghela *et al*., (2021) in wheat crop.

Table 1. Mean squares from analysis of variance (ANOVA) of eleven characters in forty genotypes of bread wheat

Source of variation	DF	Days to Heading	Days to maturity	Plant Height (cm)	Tillers per plant	Spike length (cm)	No of spikelets per spike	Grains per spike	1000 grain weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
Replication	2	1.53	2.36	12.51	1.90	3.45	3.06	27.71	6.70	44.32	22.25	2.34
Treatment	39	116.70**	46.17**	.75**	2.59**	2.04**	4.57**	258.80**	38.68**	98.13**	242.35**	12.47**
Error	78	2.04	2.49	1474.90	0.25	0.36	0.86	24.99	0.67	3.65	8.72	0.41

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

3.2 Mean performance

The average performance of 40 genotypes along with mean, SE (d) and CD are presented in Table 2. Early heading was recorded in genotype K1006 (71 days) followed by K 1317, NW 2036 and WR 544. Early maturing genotype was recognized as HD 3086 and HUW 234 (113.33 days) followed by K 1317 and Raj 3765 whereas genotype DBW 187 (132 days) was found to be late in maturity. Maximum plant height was observed in genotype Sumai 3 (109.54 cm) followed by Raj 3765. Maximum number of tillers/plants was recorded in PBW 702 (6.27) followed by PBW 698, Raj 3765, PBW 1763 and NW 5054. Maximum spike length in DPW 621-50 (11.84 cm) followed by PBW 780, PBW 701, HD 3118 and DBW 187. Genotype NIAW 1415 had maximum number of spikelets/spike (21.73) followed by DBW 88 and PBW 701. Highest number of grains/spikes was recorded in genotype HD 3118 (72.13) followed by DBW 187, PBW 702 and HUW 468. Thousand grain weight was highest in genotype DBW 222 (38.08 g) followed by PBW 677, PBW 702 and PBW 34. Maximum biological yield/plant was observed in genotype Raj 3765 (32.18 g) followed by PBW 550 and PBW 698. The genotype K 0307 was observed to have highest value of harvest index (54.06) followed by HD 3118 and C 306.

Comparing the mean values obtained for the character grain yield/plant from different genotypes, it was observed that the mean value ranged from 2.41g to 10.90g. Maximum grain yield/plant was observed in genotype HD 3118 (10.90 g) followed by DBW 187 and K 0307 while minimum grain yield/plant was noticed in genotype WR 544 (2.41 g) followed by NW 2036 and PBW 703.

Table 2.Mean performance of different characters among the genotypes of bread wheat

S. no	Genotypes	Days to Heading	Days to maturity	Plant Height (cm)	Tillers per plant	Spike length (cm)	No of spikelets per spike	Grains per spike	1000 grain weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
1	DBW 88	91.00	121.67	85.23	2.20	11.47	21.67	60.57	33.77	17.77	27.56	4.79
2	DBW 222	94.33	128.00	88.97	2.80	11.10	18.80	61.40	38.08	18.40	29.65	5.45
3	DBW 303	86.00	120.00	81.83	3.60	10.72	19.03	63.75	23.51	14.99	24.56	3.72
4	DBW 187	96.00	132.00	89.43	3.80	11.57	20.47	71.73	36.37	25.87	36.63	9.46
5	HD 3059	81.33	114.33	75.63	2.70	10.15	17.70	43.95	29.99	11.52	33.69	3.87
6	C 306	93.67	124.00	88.03	2.73	10.83	20.43	51.30	35.78	11.61	42.72	4.92
7	HD 3118	84.33	119.00	93.53	3.93	11.60	20.33	72.13	30.40	22.40	48.65	10.90
8	HD 2824	82.33	119.00	85.20	4.17	10.86	19.02	57.15	28.07	22.17	26.89	5.95
9	HD 3226	81.67	117.33	89.73	3.40	11.37	19.80	62.73	35.80	23.20	28.46	6.59
10	HD 3086	80.00	113.33	88.47	2.45	10.72	19.72	55.77	33.32	19.74	17.87	3.55
11	HUW 468	78.33	114.67	87.24	3.37	11.14	20.67	67.82	26.95	26.15	27.37	7.20
12	HUW 234	74.67	113.33	83.30	4.20	9.70	18.20	48.27	30.80	17.93	30.14	5.41
13	K 1006	71.00	117.33	91.90	3.25	11.55	20.42	56.38	31.64	24.10	21.54	5.14
14	K1317	72.67	113.67	86.70	3.33	11.37	20.03	62.60	34.70	25.57	18.90	4.85
15	K 0307	77.67	118.00	88.33	3.40	11.17	19.87	63.87	34.86	16.73	54.06	9.03
16	NIAW 1415	78.67	115.00	81.33	3.18	11.30	21.73	67.20	35.48	22.17	23.85	5.30

17	NI 5439	83.00	115.00	84.82	2.57	10.82	18.18	55.78	36.31	17.08	38.91	6.63
18	NW 1014	77.67	116.67	88.67	3.23	9.71	18.68	53.83	26.49	18.58	24.40	4.55
19	NW 5054	74.00	114.33	91.09	4.40	9.99	17.53	50.48	34.64	22.10	37.58	8.27
20	NW 2036	72.00	115.33	81.97	2.30	9.96	20.47	47.37	28.70	12.30	24.32	3.00
21	Lok 01	88.00	120.33	85.50	2.80	10.97	20.13	67.27	35.11	15.20	40.55	6.15
22	PBW 703	74.00	116.67	72.20	2.47	8.77	18.53	55.33	26.45	11.40	26.76	3.05
23	PBW 723	76.00	119.33	83.55	3.80	10.85	19.17	54.53	36.01	20.37	17.48	3.49
24	PBW 780	83.67	118.67	80.20	3.27	11.67	19.93	60.13	30.94	13.57	24.82	3.39
25	PBW 701	77.33	115.33	86.37	3.33	11.65	21.08	52.78	28.72	19.97	23.54	4.75
26	PBW 712	78.33	117.33	74.51	2.47	8.58	18.05	41.20	34.84	15.71	26.81	4.20
27	PBW 725	75.33	113.33	82.37	4.27	10.59	20.11	43.93	31.07	21.25	41.12	8.70
28	PBW 698	79.00	114.67	89.57	5.62	11.11	19.87	63.57	32.92	29.93	11.44	3.42
29	PBW 702	82.33	119.00	90.00	6.27	11.17	19.73	70.30	36.90	27.61	30.12	8.32
30	PBW 550	84.00	120.33	76.79	2.53	10.42	20.45	55.12	35.67	31.19	17.92	5.61
31	PBW 1763	81.67	116.67	85.97	4.47	10.10	20.20	51.07	32.88	26.87	28.65	7.65
32	PBW 677	83.67	120.33	89.73	3.60	11.00	20.73	42.87	36.94	20.27	25.53	5.17
33	PBW 34	77.00	117.33	91.20	3.27	11.43	18.60	60.40	36.52	21.53	35.60	7.67
34	Raj 3765	75.00	114.00	105.43	4.48	10.16	20.58	62.58	35.31	32.18	24.52	7.85
35	Sumai 3	89.67	121.33	109.54	3.08	10.16	19.32	45.58	34.10	19.08	21.54	4.12
36	WR 544	72.00	115.67	80.17	1.48	8.52	15.23	33.19	27.28	6.06	39.74	2.41
37	DPW 621-50	81.67	115.00	86.03	4.35	11.84	18.50	42.37	35.08	21.99	30.99	6.77
38	WH 147	79.00	118.33	84.70	3.47	10.73	18.87	54.93	30.23	21.40	16.43	3.52
39	WH 730	79.00	119.33	80.32	4.17	10.61	19.30	45.65	30.50	22.00	28.54	6.20
40	WH 1105	85.00	121.67	79.53	2.50	11.03	19.53	61.07	32.87	15.20	27.35	4.14
	Mean	**80.80**	**117.92**	**86.13**	**3.42**	**10.71**	**19.52**	**55.95**	**32.65**	**20.08**	**28.93**	**5.63**
	SE(d)	1.17	1.29	1.81	0.41	0.49	0.76	4.08	0.67	1.56	2.41	0.52
	C.D.	2.33	2.57	3.61	0.82	0.98	1.51	8.14	1.33	3.11	4.81	1.05

3.3 Coefficient of variation

The estimates of mean, range, variances due to Genotype and Phenotype, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for various characters studied are presented in Table 3. The PCV values were higher than GCV values for all the characters indicating the influence of environment on the expression of characters. High PCV and GCV values were observed for grain yield/plant (37.39) and (35.61), harvest index (32.17) and (30.50), tillers/plant (29.72) and (25.86), biological yield/plant (29.53) and (27.95) indicating better opportunity for improvement in these traits through selection.

However, moderate PCV and GCV was observed for grains/spike (18.13) and (15.78), 1000 grains weight (11.19) and (10.90), spike length (8.96) and 6.97), plant height (8.41) and (8.01). The lowest estimates of PCV and GCV were observed for days to maturity (3.50) and (3.24) followed by spikelets/spike and days to heading. The magnitude of PCV ranged from 3.50 for days to maturity to 37.39 for grain yield/plant. The characters with high phenotypic coefficient of variation indicated more influence of environmental factors. Similar results on variability for different characters were reported by Dhakar*et al*., (2012), Joshi *et al*., (2018), Tiwari *et al*., (2021), Yadav *et al*., (2021), Prasad *et al*., (2021) and Hassani*etal*., (2022).

3.4 Heritability and expected genetic advance

The estimates of heritability and expected genetic advance for various characters studied are shown in Table 3. Heritability estimates were highest for 1000 grains weight (95.00), followed by days to heading (94.94), grain yield/plant (90.70), plant height (90.67). High heritability indicated that the characters were least influenced by environmental factors. Fellahi*et al*., (2013), Devesh *et al*., (2018), Thapa *et al*., (2019), Hayadar*et al*., (2020) and Dashora*et al*., (2022) also estimated high heritability for important morphological traits. Lowest heritability was observed for spikelets/spike (58.98).

Highest value of expected genetic advance expressed as percent of mean was observed for grain yield/plant (69.87), harvest index (59.59) and biological yield/plant (54.50). High heritability coupled with high genetic advance (per cent of mean) was observed for grain yield/plant, harvest index and biological yield/plant which suggested that these characters can be considered as favourable for improvement through selection. 1000 grain weight, plant height and days to heading showed high heritability coupled with moderate genetic advance while high heritability with low genetic advance was observed for days to maturity. Low heritability with low genetic advance values was found for spikelets/spike and spike length indicating slow progress through selection for these characters. Similar findings were also reported by Kumar *et al*., (2017), Bhanu *et al*., (2018), Kumar *et al*., (2021), Vaghela *et al*., (2021).

Table 3.Mean, range, genotypic variance, phenotypic variance, GCV, PCV, Heritability and genetic advance for eleven characters of bread wheat

Genotypes	Mean	Min	Max	Genotypic variance	Phenotypic variance	GCV (%)	PCV (%)	Heritability %	GA	GA % of mean
Days to Heading	80.80	71.00	96.00	38.22	40.26	7.65	7.85	94.94	12.41	15.36
Days to maturity	117.92	113.33	132.00	14.56	17.05	3.24	3.50	85.41	7.26	6.16
Plant Height (cm)	86.13	72.20	109.54	47.62	52.52	8.01	8.41	90.67	13.54	15.72
Tillers per plant	3.42	1.48	6.27	0.78	1.03	25.86	29.72	75.69	1.58	46.35
Spike length (cm)	10.71	8.52	11.84	0.56	0.92	6.97	8.96	60.55	1.20	11.18

No of spikelets per spike	19.52	15.23	21.73	1.24	2.10	5.70	7.42	59.98	1.76	9.01
Grains per spike	55.95	33.19	72.13	77.94	102.93	15.78	18.13	75.72	15.83	28.29
1000 grain weight (g)	32.65	23.51	38.08	12.67	13.34	10.90	11.19	95.00	7.15	21.89
Biological yield per plant (g)	20.08	6.06	32.18	31.49	35.14	27.95	29.53	89.61	10.94	54.50
Harvest index (%)	28.93	11.44	54.06	77.88	86.60	30.50	32.17	89.93	17.24	59.59
Grain yield per plant (g)	5.63	2.41	10.90	4.02	4.43	35.61	37.39	90.70	3.93	69.87

4. CONCLUSION

From the present study it is concluded that sufficient genetic variability was present in the experimental material for most of the traits. High heritability coupled with high genetic advance (per cent of mean) was observed for grain yield/plant, harvest index and biological yield/plant which suggested that these characters can be considered as favourable for improvement through selection. High PCV and GCV values were observed for grain yield/plant, harvest index, tillers/plant, biological yield/plant indicating better opportunity for improvement in these traits through selection.

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