Original Research Article

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

ABSTRACT

Wheat (*Triticumaestivum* L.) is one the most important cereal crop grown worldwide. The genetic improvement of any breeding population largely depends on the extent of genetic variability present in a crop species. In the present investigation, forty diverse bread 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 showed highly significant differences among the genotypes for all the characters studied, indicating 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 (*Triticumaestivum* 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. *Triticumaestivum*, *Triticum durum* and *Triticumdicoccum*species of wheat are presently grown as commercial crop in India.*Triticumaestivum* known as common bread wheat is cultivated throughout India and is good for making chapati and bakery products. Carbohydrate and protein are two main components of wheat. Wheat is also an important source of dietary fibers, B vitamins, minerals, and other phytochemicals in the human diet. Wheat provides "Gluten" which is very essential for bakers. Gluten provides the structural framework for the spongy, cellular texture of bread and other bakery products.“The bran, husk and other portion of wheat grain and straw are important feed for livestock as well as source of bedding material for livestock. In order to meet the increasing demands of food due to rising population and income, food production in India need to be increased. 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, Gujarat, 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.

“Development of improved genotypes capable of producing better yield under various agro-climatic conditions and stresses is always the main objective of wheat breeding programme. 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). Mishra *et al*., (2019) observed high values of PCV over GCV for grain yield/plant and plant height indicating large amount of variation for these characters due to environment. “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 was recorded for 1000 grains weight, days to heading, number of tillers/meter, spike length and days to maturity (Akbarzai*et al*., 2023). Lamara*et al*., (2022) reported high GCV along with moderate to high heritability coupled with high genetic advance for proline content, spikes weight and grain yield/plant. “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 irrigated condition. The material used in the study comprised of forty bread wheat genotypes *viz*; DBW 88, DBW 222, DBW 303, DBW 187, HD 3059, C 306, HD 3118, HD 2824, HD 3226, HD 3086, HUW 468, HUW 234, K 1006, K 1317, K 0307, NIAW 1415, NI 5439, NW 1014, NW 5054, NW 2036, Lok 01, PBW 703, PBW 723, PBW 780, PBW 701, PBW 712, PBW 725, PBW 698, PBW 702, PBW 550, PBW 1763, PBW 677, PBW 34, Raj 3765, Sumai 3, WR 544, DPW 621-50, WH 147, WH 730 and WH 1105 made available 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/spike, number of grains/spike, 1000-grains weight (g), grain yield/plant (g), biological yield/plant (g) and harvest index (%).

2.3. Statistical analysis

The overall mean values of different characters were subjected to statistical analysis. Analysis of variance was done by subjecting the data to the statistical method on randomized block design (RBD) as described by Panse and Sukhatme (1978). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was computed according to the method suggested by Burton and de Vane (1953). Heritability in broad sense was estimated by the method as suggested by Hanson *et al.,*(1956). The expected genetic advance (GA) expressed in percentage of mean were calculated by using the method suggested by Johnson *et al.,* (1955).

3. RESULTS AND DISCUSSION

3.1 Analysis of variance

ANOVA of all the characters under study is 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**	147.75**	2.59**	2.04**	4.57**	258.80**	38.68**	98.13**	242.35**	12.47**
Error	78	2.04	2.49	4.90	0.25	0.36	0.86	24.99	0.67	3.65	8.72	0.41

** significant 1% level

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 NW 2036 (72 days), WR 544 (72 days) and K 1317 (72.67 days) respectively. Early maturing genotype was recognized as HD 3086 and HUW 234 (113.33 days) followed by K 1317 and Raj 3765 (113.67 and 114.00 respectively) 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 (105.43 cm). Maximum number of tillers/plants was recorded in PBW 702 (6.27) followed by PBW 698 (5.62), Raj 3765 (4.48), PBW 1763 (4.47) and NW 5054 (4.40). Maximum spike length was observed in DPW 621-50 (11.84 cm) followed by PBW 780 (11.67 cm), PBW 701(11.65 cm), HD 3118 (11.60 cm) and DBW 187 (11.57 cm). Genotype NIAW 1415 had maximum number of spikelets/spike (21.73) followed by DBW 88 (21.67) and PBW 701 (21.08). Highest number of grains/spikes was recorded in genotype HD 3118 (72.13) followed by DBW 187 (71.73), PBW 702 (70.30) and HUW 468 (67.82). Thousand grains weight was highest in genotype DBW 222 (38.08 g) followed by PBW 677 and PBW 702 (36.94 and 36.90 g respectively). Maximum biological yield/plant was observed in genotype Raj 3765 (32.18 g) followed by PBW 550 (31.19 g) and PBW 698 (29.93 g). The genotype K 0307 was observed to have highest value of harvest index (54.06) followed by HD 3118 and C 306 (48.65 and 42.72 respectively).

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 (9.46 g) and K 0307 (9.03 g) while minimum grain yield/plant was noticed in genotype WR 544 (2.41 g) followed by NW 2036 (3.00 g) and PBW 703 (3.05 g). Therefore, high variability for eleven traits of forty bread wheat genotypes indicated that there was reasonably sufficient variability to allow plant breeders to pick superior and desired genotypes for further improvement. In general, all of the traits studied had a wide range of variation. Fikre*et al*., (2015) and Seyoum*et al*., (2021) reported similar results on bread wheat study.

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 Genotypic and phenotypic variability

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. However, differences between them were small indicating that the influence of environment on the expression of characters was low. 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) and 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) respectively 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 while GCV ranged from 3.24 for days to maturity to 35.61 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), Olbana*et al*., (2021) and Hassani*et al*., (2022), Shah *et al*., (2023).

Days to heading and days to maturity, plant height and 1000 grains weight all had slightly greater phenotypic coefficient of variation than genotypic coefficient of variation, indicating that those traits were less impacted by the environment. Tillers/plant, spike length, number of spikelets/spike, grains/spike,biological yield/plant, harvest index and grain yield/plant were shown to have a higher phenotypic coefficient of variation than genotypic coefficient of variation, indicating that they were more influenced by the environment.

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 grains 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. The traits with moderate to high variability and genetic advance should be given attention to produce an effective response to yield enhancement. Stabilizing selection should be followed for accumulation of alleles exhibiting additive gene action. Selection and hybridization of genotypes with high genotypic coefficient of variation, heritability, and genetic advance can be recommended for further bread wheat yield enhancement in a specific area.

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