ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 03, 2022

Genetic characterization of Bread wheat (*Triticum aestivum* L.) for grain yield and its attributing traits

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Abstract

Present investigation was carried out at the research farm of Department of Genetics and Plant Breeding, Rama University, Kanpur to investigate the pattern of genetic variability and heritability in the elite genotypes of wheat germplasm. In current study 27 wheat genotypes including checks entries have been evaluated in randomized block design in three replication and the observations have been noted on the eleven metric traits viz., days to 50% flowering, days to maturity, flag leaf area (cm^2), number of tillers per plant, plant height (cm), spike length (cm), number of spikelets per spike, grain yield per plant (g), biological yield per plant (g), 1000-grains weight (g) and harvest index (%). The analysis of variance showed significant mean sum of squares due to all traits under study. High estimates of heritability were observed for all of the traits viz., grain yield per plant (97.60%) followed by 1000-grains weight (96.53%) and harvest index (94.21%), whereas, high estimates of genetic advance (>20%) in per cent over mean was recorded for the traits grain yield per plant (34.16%) followed by spike length (26.32%) and 1000-grains weight ((23.11%), High heritability accompanied with high genetic advance for the traits showed additive gene action and the selection for such traits would be rewarding.

Keywords: *Wheat, Triticum aestivum, genetic variability, heritability, genetic advance.*

Introduction

The wheat is a hexaploid (allohexaploid) species (2n =6x= 42) having AABBDD with A, B and D genome. The species of bread wheat may be divided into diploid, tetraploid and hexaploid species with chromosome number 2n=14=AA, 2n=14=BB, 2n=28=AABB and 2n=42=AABBDD respectively with basic chromosome number (x) = 7 **(Sleper and Poehlman, 2006).** However, DNA studies revealed that *Triticum urartu* is diploid and has used as donor of A genome instead of *Triticum monococcum***(Dvorak *et al.*, 1993)** and *Aegilops speltoides* which is a wild diploid; has used as possible donor of B genome.Wheat, a self-pollinating annual plant in the true grass family Gramineae (Poaceae) and genus *Triticum,* is the world's

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most famous energy rich cereal crop. It has been described as the "*King of the cereals*" because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. It is currently grown on approximately 225 mha Area globally, with an average productivity of 3 t/ha. It exhibits considerable variation between different agro-ecological zones **(Singh *et al.*, 2008).** It supplies about 25% of protein and 20% of the calories consumed by human beings from the daily diet. According to FAOSTAT, India is the second largest wheat producer in the world after China. Total food grain production is estimated to rice 2. 66% to a now record- 344.43 MT for- 2021-22 crop year higher than 291.9 MT last year. In addition, India is set to harvest a record wheat production of 115.75 MT in the 2020-21 crop year on the back of food grain according to latest government of India. Wheat production is rising year on year and the previous record of 107.86 MT was achieved during the 2019-20 crop years **(Source: www.livemint.com May, 2021).**

Genetic variability is a natural phenomenon, and for any crop species to effectively utilise it, systematic collection, appraisal, and classification based on economic characteristics are required. the necessary level of genetic diversity for effective use of direct and indirect selection. Understanding the genetic architecture of various traits and the direct and indirect selection criteria aids in developing breeding plans that maximise genetic variety for plant improvement.

Keeping the above facts in view the present investigation has been carried out to understand the pattern of genetic variability present among available germplasms.

The complex attribute of grain yield is greatly influenced by numerous environmental variables, biotic and abiotic challenges, such as water logging, salt, etc. Direct selection for yield in crop breeding programmes could be deceptive due to the complexity of the environment. As a result, knowledge of the genetic variability and the correlation between morph-agronomic variables and grain production are essential for successful selection. The correlation coefficient helps to clarify how many qualities relate to grain yield. Breeders can choose genotypes that possess a group of desired features by studying the associations between various variables.

Experimental materials and methods:

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Present experiment was carried out at research farm of Rama university mandhana, Kanpur. The experimental material for the present investigation comprised of 27 wheat genotypes including two checks *viz*., HD 2733 and PBW 502, from germplasm materials available in "Department of Genetics and Plant Breeding, Rama University, Mandhana, Kanpur. The experiment was sown in randomized block design at the experimental field. Each plot consists two rows of 2.5 m spacing of 5cm plant to plant with in the row and 20 cm between the rows. Fertilizer was applied at the rate of 120 kg N, 60 kg P and 40 kg K. These accessions were raised and followed recommended packages and practices during *Rabi* season, 2022-23 to grow a healthy crop.The observation on 11 quantitative characters *viz*., days to 50% flowering, days to maturity, flag leaf area (cm^2), number of tillers per plant, plant height (cm), spike length (cm), number of spikelets per spike, grain yield per plant (g), biological yield per plant (g), 1000-grains weight (g) and harvest index (%), were recorded to estimate genetic variability, heritability and genetic advance.

Statistical analyses:

The experimental data collected the respect of 11 characters on 27 wheat genotypes and 2 checks were compiled by taking the mean values of selected plants in each plot and subjected for following statistical analyses: Analysis of variance **(Panse and Shukhatme, 1988),** Estimation of Heritability **(Hanson *et al*., 1956)**and Genetic advance as per cent of mean **(Johnson *et al*., 1955).**

Results and Discussion

Analysis of variance:

Analysis of variance of 27 wheat genotypes including two checks have been found significant for almost all the traits. shown in table 1.

Table 1: ANOVA for 11 traits of wheat germplasm for randomized block design

Source of variation	Replications	Treatments	Error
df	2	26	52
Days to 50% Flowering	4.72	14.67**	0.83
Days to maturity	5.76	19.89**	1.64
Plant Height (cm)	2.41	137.05**	9.03
Number of tillers per plant	1.093	3.373**	0.042
Spike length (cm)	2.904	4.121**	0.117
Number of spikelets per spike	1.231	4.000**	0.41
Flag leaf area (cm^2)	0.8	35.54**	0.8
1000 grains weight (g)	2.56	47.54**	0.78

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Biological yield per plant (g)	1.21	13.71**	0.24
Harvest index (%)	2.54	110.22**	1.86
Grain yield per plant (g)	0.67	5.241**	0.053

*,** Significant at 5% and 1% level of probability respectively.

Mean performance of the entries:

Studies on range, mean, coefficient of variation (CV) and standard deviation (SD) for various trait such Days to 50% flowering, Days to maturity, Plant height (cm), Number of tillers per plant, Spike length (cm), number of spekelets per spike, Flag leaf area (cm^2), 1000 grain weigh (g), Biological yield (g), harvest index (%) and Grain yield per plant. Wide range of variability was noted for all the eleven traits under study. phenological traits under study such as Days to 50 % flowering (75.88-85.98 days), Days to maturity (114.61-123.11 days), Plant height (63.38-98-73 cm), Number of tillers per plant (6.17-8.49),Spike length (12.72-15.47 cm), flag leaf area (22.35-35.73 cm^2 days), 1000 grains weight (23.25-35.32 g), Biological yield (9.53-16.57 g), Harvest index (33.14- 54.24 %) and Grain yield per plant (4.79-9.07 g) have exhibited wade range of genetic variability (Table no. 2)

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

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Table. 2: The mean performance of genotypes for 11 characters in wheat germplasm

S. No.	Genotypes	Days to 50% Flowering	Days to maturity	Plant Height (cm)	Number of tillers per plant	Spike length (cm)	Number of spikelets/ spike	Flag leaf area (cm2)	1000 grains weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
1	NW 5054	77.97	120.06	63.38	7.59	11.09	14.5	30.7	25.24	14.74	42.7	7.3
2	CRDC-4	82.48	121.23	83.23	7.27	7.78	14.44	25.63	29.09	14.87	46.61	8.05
3	CHAP-10	78.52	118.09	81.38	7.08	7.23	12.9	29.82	33.63	11.76	50.71	7.05
4	TUKURU	75.88	121.11	98.73	6.67	7.63	14.48	29.54	32.08	12.55	33.14	4.79
5	SR-89	81.41	120.26	86.36	6.3	8.06	14.89	26.45	23.25	14.97	45.7	7.94
6	SR-86	80.25	121.76	84.92	8.25	8.62	14.12	26.34	29.46	15.49	45.78	8.21
7	KING BIRD#1	79.04	116.56	85.69	7.64	8.92	13.35	22.35	30.12	12.34	44.39	6.42
8	SR-177	78.56	120.1	83.55	7.33	7.86	13.54	25.11	26.83	9.53	54.24	6.26
9	POSTOR	80.26	120.3	89.57	7.54	8.14	13.81	26.65	25.3	11.48	43.78	5.91
10	NRI 88	81.62	123.08	86.73	7.47	7.17	14.34	31.37	28.55	12.04	39.46	5.54
11	PGQ	80.32	119.69	77.24	7.63	7.36	12.72	25.88	31.22	13.42	46.59	7.3
12	K-508	80.32	119.25	78.15	8.08	6.7	14.97	31.27	26.48	14.08	48.65	7.99
13	RAJ 4120	81.01	121.1	83.78	7.75	8.05	15.47	25.43	33.21	16.57	41.87	8
14	K-1317	77.59	121.23	82.07	7.9	8.23	14.19	31.4	29.75	16.56	34.3	6.53
15	K-818	76.87	123.09	76.67	6.79	6.77	13.75	29.73	28.21	11.85	47.54	6.64
16	AKURI	76.09	119.58	81.61	7.73	7.73	14.77	33.53	25.12	13.54	39.95	6.28
17	PUSA 2733	80.2	121.49	83.89	7.89	7.52	14.92	35.37	24.92	12.93	41.12	6.19
18	SR-152	76.77	114.61	88.45	7.39	8.37	14.56	29.89	26.72	15.95	36.98	6.8
19	RAJ 4037	81.71	118.4	85.39	7.57	8.61	15.41	30.51	25.62	16.15	38.24	7.12
20	PBW 243	80.53	121.96	80.37	8.49	7.79	13.58	30.95	34.91	15.33	50.95	9.07
21	DABU	82.34	119.43	82.33	7.61	8.21	15.47	26.86	26.51	12.94	48.84	7.41
22	RAJ 3404	85.98	123.11	81.13	7.97	7.49	14.04	29.09	28.76	13.55	51.25	8.13
23	DH 3171	80.29	117.06	89.14	7.65	6.63	13.48	27.72	28.05	12.48	40.9	5.95
24	HD-2888	80.79	122.16	92.86	7.41	6.83	13.18	27.57	28.75	16.28	39.49	7.41
25	SONALIKA	80.51	117.99	88.32	7.52	6.99	12.96	24.36	27.79	12.76	43.64	6.51
26	HD-2733	80.69	115.93	77.4	6.17	7.92	15.18	29.48	34.99	13.55	48.05	7.61
27	PBW 502	77.62	119.87	84.14	7.24	11.08	13.48	23.05	37.32	14.72	50.09	8.58
	Mean	79.84	119.94	83.57	7.48	7.95	14.17	28.37	28.96	13.79	44.26	7.07
	Min	75.88	114.61	63.38	6.17	6.63	12.72	22.35	23.25	9.53	33.14	4.79
	Max	85.98	123.11	98.73	8.49	11.09	15.47	35.37	37.32	16.57	54.24	9.07
	SE(d) ±	0.74	1.05	2.45	0.17	0.28	0.52	0.73	0.72	0.40	1.12	0.19
	C.D. at 5%	1.50	2.11	4.94	0.34	0.56	1.05	1.47	1.45	0.80	2.24	0.38
	C.V. (%)	1.10	1.03	3.46	3.47	3.63	3.78	2.89	2.76	2.95	2.79	2.86

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Heritability:

The estimates of broad sense heritability (H^2bs) and genetic advance in percent over mean (GA) for different characters are given inTable 3.

Heritability and genetic advance are important selection parameters. High estimates of heritability (>60%) were observed for all of the traits viz., grain yield per plant (97.60%) followed by 1000-grains weight (96.53%), harvest index (94.21%), biological yield per plant (93.11%), flag leaf area (92.21%), spike length (85.55%), number of tillers per plant (82.52%), days to 50% flowering (77.49 %), plant height (73.72%) and days to maturity (70.77%) except number of spikelets per spike (66.76%) which possessed moderate heritability, indicating that a plant breeder can concentrate on these traits to exploit effective selection for genetic improvement. None of the traits under investigation had low estimates of heritability. Previously, similar results for various traits were also noted by **Gautam *et al.* (2017), Gaur, (2019), Sahu *et al.* (2019),Tarkeshwar*et al.* (2019), Kumar *et al*. (2020) and Kumar *et al.* (2022).**

Genetic Advance:

Genetic advance is the improvement in the mean genotypic value of selected individual over the parental population. High estimates of genetic advance (>20%) in per cent over mean was recorded for the traits grain yield per plant (34.16%) followed by spike length (26.32%), 1000-grains weight (23.11%), harvest index (19.19%) and biological yield per plant (17.36%) Table- 1). While, moderate (10-20%) genetic advance in percent over mean were found for flag leaf area (16.15%), number of tillers per plant (15.11%) and plant height (13.19%). Further, low level (<10%) of genetic advance were observed for number of spikelets per spike, days to 50% flowering and days to maturity.Earlier, similar results for various traits were also noted by **Tarkeshwar*et al.* (2019), Kumar *et al*. (2020), Kumar *et al.* (2022)**

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Table 3: Estimates of PCV, GCV, heritability and genetic advance in 25 germplasm lines of Wheat

Genotypes	Range			Variance		h^2 (BS) (%) (Hb)	Genetic Advance	Coefficient of Variation		% contribution
	Min	Max	Mean	var (g)	var (p)		GA% mean	GCV (%)	PCV (%)	
Days to 50% Flowering	78.88	85.96	82.73	3.66	4.49	77. 49	4.30	2.31	2.56	12.36
Days to maturity	119.06	127.61	124.35	5.07	6.71	70.77	3.24	1.81	2.08	13.01
Plant Height (cm)	66.78	102.13	86.97	37.33	46.36	73.72	13.19	7.02	7.83	12.31
Number of tillers per plant	4.57	6.89	5.88	0.27	0.31	82.52	15.11	8.82	9.48	9.69
Spike length (cm)	8.13	12.59	9.45	1.15	1.26	85.55	26.32	11.33	11.89	6.66
Number of spikelets/spike	15.52	18.27	16.97	0.53	0.94	66.76	6.64	4.29	5.72	10.94
Flag leaf area (cm^2)	24.85	37.87	30.87	9.58	10.38	92.21	16.15	10.03	10.44	6.76
1000 grains weight (g)	26.25	40.32	31.96	12.25	13.03	96.53	23.11	10.95	11.30	9.11
Biological yield/plant (g)	12.33	19.37	16.59	3.16	3.39	93.11	17.38	10.71	11.10	6.93
Harvest index (%)	37.74	58.84	48.86	28.45	30.31	94.21	19.19	10.92	11.27	7.76
Grain yield per plant (g)	5.79	10.07	8.07	0.99	1.05	97.60	34.16	12.34	12.67	4.48

Coefficient of variation

Highest values of phenotypic coefficient of variation (PCV) along with genotypic coefficient of variation were estimated for grain yield per plant followed by spike length, 1000-grains weight, harvest index and biological yield per plant respectively as shown in table 3.The high variance due to genotype as well as phenotype has been observed for some traits like plant height, harvest index, 1000-grains weight and flag leaf area. The highest contribution towards variability was made by days to 50% flowering, days to maturity, plant height and number of spikelets per spike.**Mishra *et al.* (2016) and Gautam *et al.* (2017)** also found parallel results for most of the traits.

Correlation Coefficients estimates

The estimation of genotypic and phenotypic correlation coefficients is computed among eleven characters of indigenous lines of wheat under study are presented inTable 4.At genotypic level, days to 50% flowering exhibited highly significant and positive correlation with number of spikelets per spike (0.247) followed by harvest index (0.320), grain yield per plant (0.428). It possessed significant negative correlation with spike length (-0.256).Days to maturity did not exhibit highly significant positive or negative correlation with any of the traits under study.

Spike length per plant has shown highly significant and positive correlation with grain yield per plant (0.296) followed by biological yield per plant (0.294) and number of spikelets per spike (0.219).Number of spikelets per spike possessed significant positive association with flag leaf area and biological yield per plant with the correlation coefficient values 0.495 and 0.376.

Test weight (1000-grains weight) showed significant positive association with grain yield per plant (0.344) and harvest index (0.241). The trait biological yield per plant exhibited significant positive correlation with grain yield per plant and harvest index respectively with correlation coefficient of 0.566 and 0.356 respectively. Further, harvest index showed positive and significant association with grain yield (0.588). Similar finding has also been found been recorded by

Conclusion

High heritability accompanied with high genetic advance indicated that the heritability is due to additive genetic effect and selection may be effective while high heritability coupled with low genetic advance indicates pre-dominance of non-additive gene action while low heritability is exhibited due to influence of environmental interaction rather than genotypic selection for such

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 03, 2022

characters may not be rewarding. The high magnitude of heritability couple with high genetic advance in per cent of mean was observed for grain yield per plant followed by spike length, 1000-grains weight, harvest index and biological yield per plant; which indicated that good response to selection is likely to be observed for these characters. The existence of high character heritability with moderate genetic advance for flag leaf area, number of tillers per plant and plant height indicate that these characters may also provide good response to selection owing to their moderate transmissibility and variability.

At genotypic level, days to 50% flowering exhibited highly significant and positive correlation with number of spikelet's per spike followed by harvest index, grain yield per plant. Days to maturity did not exhibit highly significant positive or negative correlation with any of the traits under study. Plant height exhibited highly significant and negative correlation with harvest index followed by grain yield per plant, spike length and flag leaf area. Number of tillers per plant exhibited highly significant and positive correlation with biological yield per plant and grain yield per plant. Test weight (1000-grains weight) showed significant positive association with grain yield per plant and harvest index. The trait biological yield per plant exhibited significant positive and negative correlation with grain yield per plant and harvest index respectively with correlation coefficient respectively. Further, harvest index showed positive and significant association with grain yield.

Thus, harvest index and grain yield per plant emerged as closely correlated yield attributes. The strong positive association of grain yield with one or more of the above traits has also been observed by previous workers Singh *et al.* 2008; Sharma and Singh, 2009; Anwar *et al.,* 2009; Aydin *et al.,* 2010; Soni *et al.,* 2011; Singh *et al.,* 2012; Vimal *et al.,* 2016; Kushawaha*et al.,* 2018; Sidhu and Gill, 2019, Kumar *et al.,* 2020.

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Table 4 (a): Estimates of genotypic correlation coefficient computed between 11 characters wheat germplasm

Characters	Days to 50% Flowering	Days to maturity	Plant Height (cm)	Number of tillers per plant	Spike length (cm)	Number of spikelets/ spikes	Flag leaf area (cm2)	1000 grains weight (g)	Biological yield per plant (g	Harvest index (%)	Grain yield per plant (g)
Days to 50% Flowering	1.000	0.181	0.001	0.195	-0.256*	0.247*	-0.215	-0.101	0.150	0.320**	0.428**
Days to maturity		1.000	-0.028	0.166	-0.070	0.032	0.190	-0.017	0.074	0.105	0.159
Plant Height (cm)			1.000	-0.107	-0.375**	-0.108	-0.237*	0.014	-0.043	-0.456**	-0.428**
Numberof tillers per plant				1.000	0.035	-0.121	0.161	-0.080	0.241*	0.034	0.225*
Spike length (cm)					1.000	0.219*	-0.245*	0.144	0.294**	0.024	0.296**
Number of spikelets/ spike						1.000	0.495**	-0.344**	0.376**	-0.281*	0.085
Flag leaf area (cm2)							1.000	-0.273*	0.099	-0.347**	-0.220*
1000 grains weight (g)								1.000	0.130	0.241*	0.344**
Biological yield per plant (g)									1.000	0.356**	0.566**
Harvest index (%)										1.000	0.588**
Grain yield per plant (g)											1.000

*, ** Significant at 5% and 1% level of probability respectively.

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