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Analysis of genetic variation based on quantitative as well as quality traits in bread wheat (*Triticum aestivum* L.)

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Abstract
The present research work was conducted at Crop Research Farm, Nawabganj, C. S. A. University of Agriculture and Technology, Kanpur (U.P.) India. The experimental material for present investigation comprised of 45 F_1s developed by using 10 parent viz., KRL 210, KRL 19, KRL 370, KRL 386, KRL 350, K 1006, K 8434, K 0307, and HD 2967 and K 1313 following half diallel mating design. A total of 100 treatments with 10 parents (45 F_1s and 45 F_2s) were evaluated in respect of mean and coefficient of variation in Randomized Block Design. The highest values of phenotypic and genotypic coefficient of variation (PCV and GCV) were observed for harvest index, grain yield per plant, number of productive tiller per plant, 1000 grain weight, biological yield per plant and seed hardness. Moderate phenotypic and genotypic coefficient of variation was recorded for lysine, number of spikelets per spike, and days to flower (75%)whereas low phenotypic and genotypic coefficient of variation was observed for days to maturity and plant height in both the F_1 and F_2 generations.

Keywords: GCV, PCV, variability, and mean

Introduction
Wheat (*Triticum aestivum* L.) is the principal food grain of the world population. It constitutes the major food for billions people of the world. Among the cereals, wheat has the pride place because of vast acreage covered under cultivation, and nutritional value which supplies about 20% of the calories for the world growing population. It is the most important staple food of about two billions people (36% of the world population). The importance of the wheat is evident from the dependency of more than half of the world's population on wheat as a basic food. Nageshwar *et al.* (2021) [7].

Wheat is one of the most important cereal crop grown in different environments due to its versatile nature over the world. At global level, it was cultivated over 221.18 million ha and production of 774.74 million tones with an average productivity of 35 quintals per hectare. In India, it is grown in area of 31.36 million hectares with a production of 107.86 million tones and productivity of 34.4 quintals per hectare **(**USDA, 2021).

The assessment of genetic variability in germplasm and relationship between characters are necessary step before planning any breeding programme. Genetic improvement for quantitative and quality traits depends on the nature and amount of variability present in the genetic stock. The present study is based on 15 quantitative and quality characters measured on 100 treatments. Information on the variability was measured by mean and genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) for individual quantitative characters and through equilibrium distance over the characters.

Material and Methods
The present experiment work carried out at Crop Research Farm, Nawabganj, CSAUA&T Kanpur, (U.P.) during *Rabi* 2019-20. The experimental material consist of 100 treatments (10 parent, 45 F_1 and 45 F_2) was grown in RCBD (Randomized Complete Block Design) with three replications followed by one line of parent and F_1s, two line of F_2s.The length of each line was 3 m. withline to line and plant to plant spacing of 22.5 and10 cm. Recommended dose of fertilizer i.e. NPK @ 120:60:40 kg ha^{-1} were applied. The observations were recorded for 15 quantitative and some qualitytraits namely, days to flower (75%), days to maturity, plant height (cm), number of productive tillers, spike length (cm), number of spikelets per spike,

number of grains per spike, biological yield (g), grain yield per plant (g), 1000 grain weight (g), harvest index (%), seed hardness (kg/seed), protein content (%), tryptophan content (g per 100 g of protein), lysine content (g per 100 g of protein)

Genotypic variance

Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV)calculated using the formula as suggested by the Burton (1952) [2].

Result and Discussion

The analysis of variance for all the 15 traits was carried out for testing the significance of differences among the treatments. The mean squares for all the characters are presented in Table 1. Highly significant differences were observed among the progenies for all the 15 traits except for spike length.It was indicated significant variability in the base material as well as the material generated subsequently, involved all possible combinations except reciprocal cross.

The variation in F_1 progenies was maximum for number of productive tillers per plant followed by seed hardness, spike length, harvest index, number of spikelets per spike, tryptophan content, lysine content, number of grains per spike, protein content, grain yield per plant, biological yield per plant, 1000 grain weight, days to flower (75%), days to maturity and plant height.

The variation in F_2 progenies was maximum for number of productive tillers per plant followed by seed hardness, spike length, lysine content, harvest index, grain yield per plant, tryptophan content, spike length, protein content, number of grains per spike, biological yield per plant, 1000 grain weight, days to flower (75%), days to maturity and plant height.

The mean performance of F_1s was greater than parents for days to flower (75%), days to maturity, number of productive tillers, spike length, number of spikelets per spike, number of grains per spike, biological yield, grain yield per plant, 1000 grain weight, harvest index, seed hardness, protein content, lysine content while the mean performance of F_1s were lower than parents for plant height and tryptophan content.

The mean performance of F_1s was greater than F_2s for days to flower (75%), days to maturity, number of productive tillers, spike length, number of spikelets per spike, number of grains per spike, biological yield, grain yield per plant, harvest index, seed hardness, protein content, tryptophan content, lysine content except plant height.

The mean performance of parents was greater than F_2s for days to flower (75%), number of productive tillers, spike length, number of spikelets per spike, biological yield, 1000 grain weight, grain yield per plant, seed hardness, protein content, tryptophan content, lysine content except plant height while the mean performance of F_2s were lower than parents for maturity, number of grains per spike, 1000 grain weight and harvest index.

Genotypic variation is heritable portion of phenotypic or total variation. It's gives the variation between genotype. Environmental variation is the non- heritable portion of observable variation. GCV and PCV are categories *viz*., high (above 20%), moderate (above 10 and below 20%) and low (below 10%) suggested by Subramanian and Menon (1973).

The highest values of phenotypic and genotypic coefficient of variation (PCV and GCV) were observed for harvest index followed by grain yield per plant, number of productive tiller per plant, 1000 grain weight, biological yield per plant and seed hardness in both the generations. Similar result was found by Ali. (2008) [1] fornumber of productive tiller per plant and grain yield per plant, Kumar *et al*. (2013) [6] fornumber of productive tiller per plantand Yaqoob (2016) for yield per plant, number of tiller per plant; Jamil *et al*. (2017) [5] for grain yield per plant and 1000 grain weight; Dutamo *et al*. (2015) [3] for number of tiller per plant, spike length and 1000 grain weight; tryptophan content and number of seeds per spike were observed at phenotypic level in F_1 generation.

Moderate phenotypic and genotypic coefficient of variation was recorded for lysine followed by number of spikelets per spike, and days to flower (75%) in both the F_1 and F_2 generations; Protein content at phenotypic level and number of seeds per spike at genotypic level were recorded in both the generations; tryptophan content was observed at genotypic level in F_1 generation and at phenotypic level in F_2 generation; spike length were recorded at both level and protein content observed at genotypic level in F_2 generation. Similar result was also reported by Kumar *et al.* (2018) for number of spikelets per spike, and days to flower (75%) and spike length.

Low phenotypic and genotypic coefficient of variation was observed for days to maturity and plant height in both the generations. Protein content was observed genotypic level in both generations. Similar result were also reported by.

Table 1: Analysis of variance for 15 characters of 10 parents - diallel cross (Parents + F_1s + F_2s) in wheat

Source of variation	d.f.	Days to flower (75%)	Days to Maturity	Plant height (cm)	Number of productive tillers per plant	Spike length (cm)	Number of spikelets per spike	No. of grains per spike	Biological yield per plant (g)
Replication	2	1.36	3.74	3.30	0.56	1.39	0.43	5.44	1.71
Treatment	99	59.40**	91.59**	72.99**	7.66**	6.62**	8.49**	90.09**	174.69**
Parents	9	71.13**	127.12**	98.17**	6.59**	1.23	4.01**	133.31**	66.38**
F_1	44	59.98**	81.59**	71.64**	6.36**	7.72**	5.81**	84.71**	174.39**
Parents vsF_1	1	7.60**	19.89**	80.30**	12.44**	22.31**	2.60*	427.64**	97.29**
F_2	44	48.60**	88.93**	68.14**	6.76**	5.41**	9.78**	76.94**	190.08**
Parents vsF_2	1	101.14**	230.01**	1.52	9.71**	1.10	23.79**	85.40**	30.98**
Error	198	1.71	3.49	1.69	1.10	0.94	1.37	4.67	2.52

Source of variation	d.f.	1000 grain weight (gm)	Harvest index (%)	Seed hardness (kg)	Protein content (%)	Lysine content (%)	Tryptophan content (%)	Grain yield per plant (g)
Replication	2	0.50	3.50	0.36	0.14	0.006	0.007	0.94
Treatment	99	117.24**	166.60**	7.30**	2.21**	0.203**	0.041**	24.23**
Parents	9	35.06**	68.10**	3.17**	1.71**	0.351**	0.027**	25.84**
F_1	44	111.99**	174.94**	6.04**	1.42**	0.169**	0.055**	25.55**

Parents vs F_1	1	135.06**	99.28**	12.45**	0.48	0.283**	0.007	49.08**
F_2	44	139.65**	183.61**	6.41**	2.59**	0.175**	0.030**	20.47**
Parents vs F_2	1	18.08**	88.57**	14.11**	5.81**	0.074	0.031**	0.04
Error	198	1.05	7.03	0.97	0.37	0.032	0.005	0.95

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

Table 2: Mean and range of parents and their F_1s and F_2s for 15 characters in wheat**.**

	Characters	Parent			F_1			F_2		
		Mean	Range		Mean	Range		Mean	Range	
1	Days to flower (75%)	83.93	75.23	91.8	84.39	74.57	93.73	82.06	72.23	82.06
2	Days to Maturity	124.97	120.67	137.97	127.45	116.77	138.57	125.37	136.17	125.37
3	Plant height (cm)	124.21	112.77	130.3	122.72	112.77	131.93	124.14	133.2	124.14
4	No of productive tillers plant	10.673	8.53	13.67	11.26	7.7	13.77	10.02	6.7	10.02
5	Spike length (cm)	11.81	10.8	12.8	12.59	7.6	15.43	11.81	8.87	11.81
6	No of spikelets per spike	20.37	18.7	22.53	20.4	15.97	23.4	19.38	14.6	19.38
7	No. of grains / spike	55.52	47.17	68.13	58.94	47.17	70.67	57.39	46.13	57.39
8	Biological yield per plant (gm)	50.78	43.73	58.73	52.41	39.27	71.87	49.66	34.73	49.66
9	1000 grain weight (g)	39.08	32.8	45.4	41	32.6	59.3	39.94	31.57	39.94
10	Harvest index (%)	34.77	24.91	43.51	36.42	15.12	56.05	36.40	12.95	36.40
11	Seed hardness (kg)	11.79	9.47	12.93	12.37	9.43	15.27	11.01	8.2	11.01
12	Protein content (%)	12.38	11.19	13.82	12.5	11.19	14.22	11.91	10.46	11.91
13	Lysine (%)	2.81	2.37	3.4	2.89	2.37	3.4	2.75	2.15	2.75
14	Tryptophan content (%)	1.38	1.23	1.55	1.37	1.08	1.64	1.34	1.1	1.34
15	Grain yield per plant (gm)	17.67	75.23	91.8	18.83	7.9	24.33	17.72	7.8	17.72

Table 3: Coefficient of variance for 15 characters in wheat

Characters		var (g)	var (p)	GCV (%)	PCV (%)
Days to flower (75%)	F_1	19.67	21.54	5.26	5.50
	F_2	17.17	18.99	5.04	5.30
Days to Maturity	F_1	28.22	31.60	4.17	4.41
	F_2	31.54	34.81	4.47	4.69
Plant height (cm)	F_1	24.73	26.77	4.05	4.22
	F_2	23.31	25.26	3.89	4.05
Number of productive tillers plant	F_1	1.85	2.80	12.10	14.87
	F_2	1.85	3.09	13.39	17.29
Spike length	F_1	1.97	2.97	11.15	13.68
	F_2	1.24	2.12	9.44	12.32
Number of spikelets per spike	F_1	1.31	2.8	5.54	8.16
	F_2	2.62	3.85	8.26	10.02
No. of grains per spike	F_1	30.61	37.95	9.39	10.45
	F_2	26.56	33.38	9.03	10.13
Biological yield per plant (gm)	F_1	51.01	52.95	13.63	13.88
	F_2	54.54	57.44	14.81	15.20
1000 seeds grain weight (gm)	F_1	32.86	33.87	13.98	14.19
	F_2	39.59	40.79	15.82	16.05
Harvest index	F_1	49.84	56.05	19.38	20.56
	F_2	51.78	59.03	19.81	21.15
Seed Hardness	F_1	1.54	2.60	10.03	13.04
	F_2	1.69	2.64	11.63	14.55
Protein content	F_1	0.39	0.67	5.00	6.56
	F_2	0.71	1.09	7.02	8.71
Lysine	F_1	0.06	0.08	8.39	9.96
	F_2	0.05	0.10	8.39	11.19
Tryptophan content	F_1	0.01	0.02	8.76	10.53
	F_2	0.01	0.01	6.56	8.69
Grain yield per plant (gm)	F_1	8.51	9.01	15.49	15.94
	F_2	6.56	7.86	14.46	15.83

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