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Studies of variability, heritability and genetic advance in some quantitative characters in bread wheat (*Triticum aestivum* L.)

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Abstract
Twenty genotype of wheat were evaluated in randomized block design (RDB) with three replication for yield and yield contributing traits during 2016-2017, find out genetic variability, Heritability and genetic advance percent of mean. Analysis of variance for the design of experiments has been present in for all the eleven characters. The square due to treatment were highly significant for all the eleven characters in both (E_1 & E_2) conditions except for number of spikelets per spike and number of grains per spike in E_1 condition. Phenotype coefficient of variation revealed that grain yield per plant exhibited highest value of PCV followed by biological yield per plant, number of number of effective tillers per plant, number of grains per spike, plant height and number of spikelets per spike. The maximum value of genotypic coefficient of variation was found for grain yield per plant followed by number of effective tillers per plant, biological yield per plant and plant height. High heritability estimates were associated with high estimates of genetic advance for plant height, number of effective tillers per plant, biological yield per plant and grain yield per plant which in fact demonstrated the presence of additive gene effects indicating effectiveness of selection for improvement of these traits.

Keywords: Variability, heritability genetic advance, quantitative characters and bread wheat

Introduction
Wheat (*Triticum aestivum* L. em. Thell.; 2n=42) is a self-pollinated crop of the member of *Poaceae* family and one of the most leading cereal of many countries of the world including India. It is the most important food crop of India and is a main source of protein and energy. In India, wheat is the second most important food crop after rice both in terms of area and production. It is a C_3 plant grown in temperate, irrigated to dry and high-rain-fall areas and in warm, humid to dry, cold environments. The record production in the country during last few years has enabled India to attain the position of being second largest producer of the wheat in the world. In India during 2018 the area under wheat was 29.90 m ha with the production 93.90 million tonnes and productivity 3140 kg/ha. Haryana state on the whole has achieved a productivity level of 5.03 tonnes per ha on 2.5 million hectares. Hence in present investigation and attempts was needed to assess the variability of important grain yield and biological yield contribution traits along with the indicate of variability *i.e.* genotypic coefficient variation (GCA), phenotypic coefficient variation (PCV), environment coefficient variation (ECV), heritability in broad sense (h^2bs), genetic advance (GA) percent of mean.

Method and materials
The experiment was conducted to examine the genetic variability heritability and genetic advance percent of mean for eleven morphological traits in bread wheat (*Triticum aestivum* L.). was conducted at Main Experiment Station of Department of Genetics & Plant Breeding, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Ayodhya (U.P.) during *rabi*, 2016-17. The experimental material for present investigation comprised of 55 F'$_1$s developed by crossing 20 lines *viz*., DBW-14, HUW-234, K-8962, NW-1014,Raj-4394, Raj-1350, NIAW-1994, MP-3382, HI-1000, GW-455, PHSL-10 HD-2932,DBW-154, PHSL-11, NIAW-2064,PBW-681, HPW-411,VL-977,UP-2864HD-4728 following Randomized Complete Block design. A total of 106 treatments (80 F_1's, 20 parents including two checks and four testers) were used for the study of 13 quantitative characters in Wheat. The entries were sown in a single row plot of 3 m length with inter and intra-row spacing of 23 cm and 18 cm, respectively. Recommended agronomic practices were adopted to raise a good crop. The observations recorded on eleven characters *viz*., days to 50 % flowering, days to maturity, plant height (cm), number of effective tillers per plant, flag leaf area (cm^2), chlorophyll content

(mg/100g), spike length (cm), peduncle length (cm), seed per spike, 1000-grain weight (Test Weight) (g), biological yield (g), grain yield per plant (g) and harvest index (%). The analysis of variances estimated by Sukhatme (1967), heritability in broad sence (Hbs) and genetic advance (GA) (Crumpacker and Allard, 1962) [4] and (Robinson *et al*., 1949) [14] were estimated.

Result and discussion

Analysis of variance for the design of experiments has been present in Table 1 for all the eleven characters. The square due to treatment were highly significant for all the eleven characters in both (E_1 & E_2) conditions except for number of spikelets per spike and number of grains per spike in E_1 condition. The existence of genetic variability in the population provides ample opportunities for selection being effective. The pool of genotypes was therefore, assessed for variability analysis. The existence of wide diversity among the constituent genotypes with regard to characters under study was confirmed through various statistical parameters. The basic material therefore, offers positive opportunities for investigation furtherance of the aforesaid objectives.

The estimates of variability, heritability (broad Sense) and genetic advance per cent of mean have been presented for E_1 condition in Table 2. The difference between PCV and GCV were high for number of grain per spike followed by number of spikelets per spike and grain filling period indicating of more environmental influence. PCV were slightly higher than GCV for all the characters. The result of phenotype coefficient of variation revealed that grain yield per plant exhibited highest value of PCV (18.89%) followed by biological yield per plant (17.45%) number of number of effective tillers per plant (17.35%), number of grains per spike (8.71%), plant height (8.65%) and number of spikelets per spike (7.82%). The maximum value of genotypic coefficient of variation was found for grain yield per plant (18.25%) followed by number of effective tillers per plant (17.15%), biological yield per plant (16.80%) and plant height (8.50%). The highest environmental coefficient of variation was observe for number of grains per spike (7.22%) followed by number of spikelets per spike (6.58%), biological yield per plant (5.04%) and grain yield per plant (4.86%) showed conformity with finding of Panwar and Singh (2000) [10], Kumar *et al.* (2003) [7], Cheema *et al.* (2006) [3] and Nagireddy and Jyothula (2009) [8]. High heritability estimates were associated with high estimates of genetic advance for plant height, number of effective tillers per plant, biological yield per plant and grain yield per plant which infact demonstrated the presence of additive gene effects indicating effectiveness of selection for improvement of these traits. High heritability coupled with moderate genetic advance was obserwed for only harvest index. The highest heritability was observed for number of effective tillers per plant (97.75%) followed by plant height (96.59%), grain yield per plant (93.38%), biological yield per plant (91.74%), harvest index (76.41%) and 1000-grain weight (75.43%). the estimates of high genetic advance as per cent of mean was noticed for grain yield per plant (46.57%), number of effective tillers per plant (44.77%), biological yield per plant (42.49%) and plant height (20.13%). Similar finding were reported by Kisana *et al.* (1982) [5], Abid *et al.* (1993) [1], Prasad *et al.* (2006) [12], Payal *et al.* (2007) [11], Yousaf *et al.* (2008) [15], Rahman *et al.* (2008) [13], Nagireddy and Jyothula (2009) [8]. High to medium values of heritability estimates were found associated with moderate expected and actual gain in the most traits. These obtained result indicated that, these traits could be used in the early generation, but would be more effective if postponed to late generation (Kaumber and Gammaal, 2012).

The estimates of variability, heritability in broad sense and genetic advance percent of mean have been presented in E_2 condition in 3. The difference between PCV and GCV were high for number of grains per spike followed by number of spikelets per spike, biological yield per plant and grain yield per plant. PCV were slightly higher than GCV for all parameters indicating presence of environmental influence on the expression of characters. The result of phenotypic coefficient of variation revealed that grain yield per plant (19.19%) showed maximum followed by biological yield per plant (19.83%), number of effective tillers per plant (15.67%), number of grains per spike (7.36%), plant height (6.96%) and number of spikelets per spike (6.39%). The maximum GCV value was observed for grain yield per plant (17.73) followed by biological yield per plant (17.28%), number of effective tillers per plant (14.95%), plant height (6.65%) and1000-grain weight (4.25%). Similar finding were reported by Panwar and Singh (2000) [10], Kumar *et al.* (2003) [7], Cheema *et al.* (2006) [3] and Nagireddy and Jyothula (2009) [8]. High heritability coupled with high genetic advance was obserwed for number of effective tillers per plant, biological yield per plant and grain yield per plant while high heritability coupled with moderate genetic advance for plant height and 1000-grain weight. Which demonstrated the presence of additive gene effects indicating effectiveness of selection for improvement of these traits. The highest heritability was found for plant height (91.52%) followed by number of effective tillers per plant (91.03%), 1000-grain weight (81.53%), days to 50% flowering (80.01%) grain yield per plant (79.28%), harvest index (76.50%) and biological yield per plant (75.95%). The estimate of high genetic advance percent of mean was found for grain yield per plant (41.68%) followed by biological yield per plant (39.77%) and number of effective tillers per plant (37.66%). Similar findings were reported by Kisana *et al.* (1982) [5], Abid *et al.* (1993) [1], Prasad *et al.* (2006) [12], Payal *et al.* (2007) [11], Yousaf *et al.* (2008) [15], Rahman *et al.* (2008) [13], Nagireddy and Jyothula (2009) [8] and Kaumber and Gammaal (2012).

Table 1: Analysis of variance for 13 characters in bread wheat (E_1) and (E_2)

Characters / d.f	Source of variation					
	Replication		Treatments		Error	
	2		105		210	
	E_1	E_2	E_1	E_2	E_1	E_2
Days to 50% flowering	8.51**	0.54	2.23**	6.40**	1.26**	2.39
Days to maturity	83.43**	1.34	55.94**	12.87**	51.09	4.49
Plant height (cm)	0.24	47.34**	94.11**	46.55**	0.36	5.89
Tillers per plant	37.76**	1.67**	1.15	0.49**	1.12	0.14
Flag leaf area (cm^2)	0.37	10.93**	1.08**	1.32**	0.63	0.36
Chlorophyll content (mg/100g)	141.99**	23.14**	5.48	14.00**	4.54	4.61

Spike length (cm)	5.38**	3.57**	0.19*	0.37**	0.13	0.31
Peduncle length (cm)	7.09**	6.93**	0.93*	1.43**	0.67	0.87**
Number Seeds per spike	16.89**	8.13**	0.49	0.83	1.12	1.46
1000-grain weight (g)	55.34**	56.56**	3.92**	2.67**	1.34**	0.68
Seed yield per plant (g)	14.71**	2.63	3.98**	0.37	1.45**	0.94
Biological yield per plant (g)	534.64**	3.50	36.80**	1.00	16.09**	1.40
Harvest index (%)	134.91**	49303.11	14.57**	49694.76	5.53**	49793.59

*, ** significant at 5% & 1% probability levels, respectively.

Table 2: Estimate of range, coefficient of variance (PCV, GCV and ECV), heritability and genetic advance for characters in bread wheat under (E_1) and (E_2)

S. No.	Characters	Range		General mean		PCV (%)		GCV (%)		ECV (%)		Heritability (bs) (%)		Genetic advance		GA in % of mean	
		E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
1.	Days to 50% flowering	79.00-82.67	70.67-76.34	81.00	73.40	1.58	2.63	0.70	1.57	1.38	2.10	20.3	35.8	0.52	1.42	0.65	1.94
2.	Days to maturity	121.67-126.34	109.34-117.67	122.95	113.57	5.90	2.37	1.03	1.47	5.81	1.86	3.1	38.3	0.45	2.13	0.37	1.87
3.	Plant height (cm)	79.78-104.80	70.07-88.92	93.69	79.83	6.00	5.52	5.96	4.61	0.64	3.04	98.9	69.7	11.45	6.33	12.22	7.93
4.	Tillers per plant	4.14-7.74	3.54-5.34	6.16	4.22	17.28	12.10	1.77	8.11	17.19	8.98	1.0	44.9	0.02	0.47	0.37	11.20
5.	Flag leaf area (cm^2)	19.38-23.38	16.27-19.20	20.67	17.60	4.27	4.70	1.86	3.20	3.84	3.44	19.1	46.4	0.34	0.79	1.67	4.49
6.	Chlorophyll content (mg/100g)	60.00-65.86	46.94-58.00	62.67	53.23	3.51	5.22	0.89	3.32	3.40	4.03	6.4	40.4	0.29	2.31	0.46	4.35
7.	Spike length (cm)	8.74-9.90	6.10-7.94	9.31	6.93	4.25	8.38	1.47	2.06	3.98	8.13	12	6.0	0.09	0.07	1.05	1.04
8.	Peduncle length (cm)	18.91-21.85	17.12-20.28	20.23	18.45	4.30	5.58	1.45	2.34	4.05	5.06	11.4	17.6	0.20	0.37	1.01	2.02
9.	Seeds per spike	17.67-19.00	14.67-18.00	18.31	16.71	5.20	6.68	2.47	2.72	5.76	7.22	22.7	-16.7	-0.44	-0.38	-2.43	-2.29
10	1000-seed weight (g)	36.90-42.35	37.18-41.49	39.42	39.05	3.76	2.97	2.35	2.08	2.93	2.11	39.3	49.2	1.20	1.17	3.04	3.01
11	Seed yield per plant (g)	15.43-20.51	14.82-16.59	17.67	15.73	8.56	5.52	5.21	2.77	6.79	6.18	37.1	-25.2	1.15	-0.45	6.54	-2.87
12.	Biological yield per plant (g)	36.60-50.45	32.51-36.82	44.34	36.03	10.81	3.12	5.92	1.01	9.04	3.29	300.0	-10.5	2.96	-0.24	6.68	-0.67
13.	Harvest index (%)	39.37-48.25	39.52-1366.31	43.49	53.76	6.72	414.92	3.99	10.67	5.53	415.06	35.3	-0.1	2.12	-0.30	4.88	-0.56

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