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GENETIC VARIABILITY FOR GRAIN YIELD AND YIELD COMPONENTS IN F_7 GENERATION OF WHEAT (*Trticum aestivum* L.)

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ABSTRACT
The present investigation was undertaken with nineteen genotypes of wheat, (including one check) during *Rabi* 2016-17 in a randomized block design with three replications at field experimentation center of Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology & Sciences. The data were recorded for fifteen characters to study genetic variability, heritability, genetic advance, correlation and path analysis. Analysis of variance among 19 genotypes showed highly significant differences for all the characters indicated the presence of substantial amount of genetic variability. On the basis of mean performance the highest grain yield was observed in genotype NW-1014 X AAI-12. The estimates of GCV and PCV were high for grain yield per plant and biological yield and moderate for tillers per plant, harvest index, peduncle length, flag leaf length, spike length, 1000 grain weight, no of grains per spike. High heritability estimate were recorded for all the characters. Moderate to low genetic advance was observed for peduncle length (12.00) and flag leaf width (0.25). High genetic advance as percent of mean was recorded for grain yield per plant (51.03), biological yield (47.09), tillers per plant (31.25), peduncle length (29.28). The characters like biological yield, tillers per plant, 1000 grain weight, harvest index, spike length, spikelets per spike and grains per spike were positively and significantly correlated with grain yield per plant at genotypic and phenotypic level. Path analysis indicated that harvest index, biological yield, spike length, spikelets per spike, peduncle length, days to maturity, days to 50% flowering and plant height per plant had maximum positive direct effect on grain yield per plant indicating that these characters could be used as selection criteria for yield improvement.

KEYWORDS: Wheat (*Triticum aestivum* L.), genetic variability, correlation and path analysis.

INTRODUCTION

Wheat is the world's most widely cultivated food crop. It is eaten in various forms by more than one thousand million human beings in the world. In India it is second important staple food crop as well as most consumed cereal next to rice. Wheat a cereal grass of the Gramineae (Poaceae) family and of the genus *Triticum,* is the world's largest cereal crop. It has been described as the 'King of Cereals' because of the acreage it occupies, high productivity and the prominent position in agriculture and economic perspective of our country. It holds in the international food grain trade. Wheat is easily transported and stored and it is used to produce a large variety of foods that include many kinds and types of breads, cakes, noodles, crackers, breakfast foods, biscuits, cookies and confectionary items ecologically suitable and contain high amount of nutrients. It compares well with other cereals in nutritive value. Unlike other cereals, wheat contains a high amount of gluten, the protein that provides the elasticity necessary for excellent bread making

In India, it is the staple diet in the northern and central regions. It is cultivated on 15.4% of the arable land in the world in almost all countries, except the humid and high-temperature areas in the tropics and high-latitude environments. Accounting for a fifth of humanity's food, wheat is the second only to rice which provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 developing countries (Braun *et al.*, 2010). At global level wheat occupies an area of 222.61 million hectares, with a production and productivity of 750.49 million metric tons and 3.39 tonnes per hectare respectively (United States Department of Agriculture, 2017) In India, wheat is being grown on 30.6 million ha area with production of 98.4 million tonnes and productivity of 3.22 tonnes/ha. In Uttar Pradesh, wheat is being grown on 9.95 million ha area with production and productivity of 30.24 million tonnes and 3.04 tonnes/ha respectively (DWR Annual Report, 2016).Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan are important states from the point of both area and production. The substantial improvement in production is utmost necessary not only to meet ever increasing food requirement for domestic consumption, but also for export to earn foreign exchange. To feed the growing population, the country's wheat requirement by 2030 has been estimated at 100 million metric tonnes and to achieve this target, wheat production has to be increased and this can be achieved through horizontal approach i.e. by increasing area under cultivation or through vertical approach i.e. varietal/ hybrid improvement, which is one of the strongest tool to take a quantum jump in production and productivity under various agro- climatic conditions **(**Singh, 2018). Genetic variability for yield and yield components is essential in the base population for successful crop improvement. The correlation coefficients are helpful in determining the components of a complex

trait like yield, but the information on the relative importance of direct and indirect effects of each component character towards yield is not provided by such studies. Path coefficient analysis is helpful in partitioning the correlation coefficients in to its direct and indirect effect, so that the relative contribution of each component character to yield could be assessed.

In view of these facts, nineteen wheat genotypes were evaluated in this study to estimate genetic variability, correlation coefficient and direct and indirect effect of yield and yield components on grain yield to screen out the suitable genotype for exploitation in a breeding programme aimed at improving grain yield potential of wheat.

MATERIALS & METHODS

The present experiment was undertaken at field of Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, technology and Sciences Allahabad, Utter Pradesh, INDIA during *rabi* 2016-17. 19 genotypes of wheat were grown in this experiment. Experiment was done according to randomized block design with three replications, and recommended package of practices were followed to raise the crop. Seeds were sown with row to row spacing of 25 cm and plant to plant spacing of 5 cm. The data were recorded on five randomly selected plants of each replication for all characters but in case of days to days to 50% heading, days to 50% flowering and days to maturity, the observations were recorded on plot basis, pre-harvest observations are Days to 50% heading, Days to 50% flowering, Plant height (cm), Number of Tillers per plant, Flag leaf length (cm), Flag leaf width (cm), Spike length (cm), Peduncle length (cm), Number of spikelets per spike, Number of grains per spike, Days to maturity and Post harvest observations are Biological yield (g), Grain yield per plant (g), Harvest index (%), 1000 grain weight (g). Mean values were computed and data were analyzed for analysis of variance as suggested Fisher (1935) given in table :1. phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were given by Burton (1952). Heritability in broad sense was given by Burton and Devane (1953). Genetic advance was given by Lush and Johnson *et al.* (1955). Genotypic and Phenotypic correlation coefficient was given by Al Jibouri *et al.* (1958). Dewey and Lu *et al.* (1959) was used to perform the path analysis for grain yield and yield components keeping grain yield is resultant variable and its components is casual variables.

RESULTS & DISCUSSION

The mean sum of squares due to genotypes showed significant differences for all fifteen characters under study, suggested that the genotypes were genetically variable (Table 1). This indicates that there is ample scope for selection of promising lines from the present gene pool for yield and its components. Thus, it indicates ample scope for selection for different quantitative characters for wheat improvement. Asif *et al*. (2004) and Kumar *et al*. (2009) also reported considerable genetic variability for grain yield and its component characters in wheat.

GCV was observed high for grain yield per plant (25.98), biological yield per plant (23.08) and moderate estimate for tillers per plant (15.67), peduncle length (14.43), flag leaf length (12.75), harvest index (12.38), 1000 grain weight (11.51), spike length (11.36), no of grains per spike (10.88).Whereas flag leaf width (9.10), no. of spikelets per spike (8.77), days to 50 % heading (7.68), days to 50 % flowering (6.68), plant height (4.29), day to maturity (2.83) exhibited low genotypic coefficient of variation. PCV also showed a similar trends in all the traits studied and was estimated to be high for grain yield per plant (27.24), biological yield per plant (23.31) and moderate estimate for tillers per plant (16.19), harvest index (15.61), peduncle length (14.64), flag leaf length (14.06), spike length (11.69), 1000 grain weight (11.59), no of grains per spike (11.13). Whereas flag leaf width (9.98), no. of spikelets per spike (9.62), days to 50 % heading (8.01), days to 50 % flowering (6.98), plant height (5.36), day to maturity (3.03) depicted low phenotypic coefficient of variation. The values of PCV were higher than GCV for all the characters which reflect the influence of environment on the expression of characters. Similar finding was also reported by Kumar *et al.* (2013). All characters showed maximum heritability in 19 genotypes. The estimates of heritability (%) in broad sense for 15 characters studied, which range from 62.72% to 98.66%. higher estimation of heritability were recorded for 1000 grain weight (98.66%) followed by biological yield (98.02%), peduncle length (97.12%), no. of grains per spike (96.61%), tillers per plant (94.70%), spike length (94.48%), days to 50% heading (92.03%), days to 50% flowering (91.43%), grain yield per plant (90.93%), days to maturity (87.43%), flag leaf width (83.07%), no. of spikelets per spike (83.02%), flag leaf length (82.30%), plant height (64.30%) and harvest index (62.72%). Therefore selection of high heritability found character will be worth full for further improvement. (Table: 2)

The genetic advance indicate a good scope for improvement for almost all the characters studied as revealed by the genetic advance expressed as percentage of mean. The genetic advanced (as percent of mean) varied from 5.46% to 51.03%. Maximum genetic advance was recorded for grain yield per plant (51.03%) followed by biological yield (47.09%), whereas minimum genetic advance was recorded for days to maturity (5.46%) followed by plant height (7.09%).

The high heritability estimates coupled with high genetic advance as percent of mean for grain yield per plant, biological yield, tillers per plant, peduncle length, flag leaf length, 1000 grain weight, spike length, no of grains per spike indicate that all these character are governed by additive gene action and as such are expected to exhibit improvement for such traits by direct selection. Similar result was reported by Sharma *et al.* (2018).

Biological yield, tillers per plant, 1000 grain weight, harvest index, flag leaf width, spikelets per spike, grains per spike showed positive significant correlation at genotypic level with seed yield per plant hence selection for these traits could be helpful for the improvement of genotype. Similar results were reported by Kumar *et al.*, (2013), Sabit *et al.* (2017).

Biological yield, harvest index, spike length, spikelets per spike, peduncle length, days to maturity, days to 50% flowering and plant height displayed positive direct effect on grain yield. This justifies that the presence of true

relationship between these characters and grain yield, there by direct selection through these characters would result reasonable effect on grain yield while, grains per spike, days to 50% heading, tillers per plant, flag leaf width, 1000 grain weight and flag leaf length depicted negative direct effect on grain yield.

TABLE 1: Analysis of variance for different fifteen characters in Wheat

S. No.	Characters	Mean Sum of Squares		
		Replications (df = 2)	Treatments (df = 18)	Error (df = 36)
1	Days to 50% heading	0.49	88.90**	2.49
2	Days to 50% flowering	0.44	90.37**	2.73
3	Plant height	1.72	56.79**	8.87
4	Tillers per plant	0.13	4.12**	0.09
5	Flag leaf length	1.43	27.63**	1.86
6	Flag leaf width	0.01	0.06**	0.00
7	Spike length	0.13	4.12**	0.08
8	Peduncle length	1.02	105.91**	1.04
9	No. of spikelets per spike	0.21	6.29**	0.40
10	No. grains per spike	1.95	64.37**	0.97
11	Days to maturity	2.12	36.71**	1.68
12	1000 Grain Weight	0.04	80.00**	0.36
13	Grain yield per plant	0.06	7.92**	0.25
14	Biological yield	0.07	41.58**	0.27
15	Harvest index	20.04	80.89**	13.38

* Significant at 5% level and ** significant at 1% level

TABLE 2: Genetic parameter for 15 characters of 19 Wheat genotypes

S.NO	Character	GCV (%)	PCV (%)	h^2bs %	GA	GA as % mean
1	Days to 50% heading	7.68	8.01	92.03	10.61	15.18
2	Days to 50% flowering	6.68	6.98	91.43	10.65	13.15
3	Plant height	4.29	5.36	64.30	6.60	7.09
4	Tillers per plant	15.67	16.19	94.70	2.31	31.25
5	Flag leaf length	12.75	14.06	82.23	5.48	23.82
6	Flag leaf width	9.10	9.98	83.07	0.25	17.08
7	Spike length	11.36	11.69	94.48	2.32	22.75
8	Peduncle length	14.43	14.64	97.12	12.00	29.28
9	No. of spikelets/spike	8.77	9.62	83.02	2.63	16.46
10	No. grains per spike	10.88	11.13	96.61	9.26	21.93
11	Days to maturity	2.83	3.03	87.43	6.58	5.46
12	1000 Grain Weight	11.51	11.59	98.66	10.54	23.55
13	Grain yield per plant	25.98	27.24	90.93	3.14	51.03
14	Biological yield	23.08	23.31	98.08	7.57	47.09
15	Harvest index	12.36	15.61	62.72	7.74	20.17

TABLE 3: Genotypic correlation coefficients among 15 characters of Wheat

No	Character	Days to 50% Heading	Days to 50% Flowering	Plant Height	Tillers/ Plant	Flag Leaf Length	Flag Leaf Width	Spike Length	Peduncle Length	Spikelets/ Spike	Grains/ Spike	Days to Maturity	1000 Grain Weight	Biological Yield	Harvest Index	Grain Yield/ Plant
1	Days to 50% Heading	1.00	0.996**	0.502**	-0.114	-0.133	-0.223	0.041	0.218	0.368**	0.368**	-0.117	-0.122	0.342**	-0.466**	0.062
2	Days to 50% Flowering		1.00	0.472**	-0.138	-0.130	-0.268*	0.013	0.202	0.392**	0.360**	-0.165	-0.060	0.346**	-0.448**	0.076
3	Plant Height			1.00	-0.082	0.345**	0.126	0.562**	0.841**	0.412**	0.301*	-0.035	-0.061	0.039	-0.215	-0.019
4	Tillers/ Plant				1.00	0.246	0.339**	0.309*	-0.198	-0.054	-0.084	-0.279*	0.374**	0.702**	0.398**	0.811**
5	Flag Leaf Length					1.00	0.494**	0.648**	0.557**	0.142	-0.009	-0.449**	0.412**	0.115	0.440**	0.350**
6	Flag Leaf Width						1.00	0.811**	0.275*	0.192	0.031	0.075	0.144	-0.016	0.467**	0.230
7	Spike Length							1.00	0.454**	0.418**	0.293*	-0.231	0.242	0.182	0.506**	0.445**
8	Peduncle Length								1.00	0.348**	0.157	0.001	0.000	-0.234	0.044	-0.139
9	Spikelets/ Spike									1.00	0.972**	-0.225	-0.138	0.325**	0.193	0.423**
10	Grains/ Spike										1.00	-0.163	-0.260*	0.329**	0.115	0.383**
11	Days to Maturity											1.00	-0.453**	-0.618**	-0.082	-0.611**
12	1000 Grain Weight												1.00	0.324*	0.417**	0.485**
13	Biological Yield													1.00	-0.051	0.868**
14	Harvest Index														1.00	0.451**
15	Grain Yield/ Plant															1.00

** Significant at 1% level,* Significant at 5% level

TABLE 4: Phenotypic correlation coefficients among 15 characters of Wheat

No	Character	Days to 50% Heading	Days to 50% Flowering	Plant Height	Tillers/ Plant	Flag Leaf Length	Flag Leaf Width	Spike Length	Peduncle Length	Spikelets/ Spike	Grains/ Spike	Days to Maturity	1000 Grain Weight	Biological Yield	Harvest Index	Grain Yield/ Plant
1	Days to 50% Heading	1.000	0.976**	0.354**	-0.131	-0.098	-0.204	0.031	0.198	0.333*	0.359**	-0.097	-0.118	0.309*	-0.315*	0.078
2	Days to 50% Flowering		1.000	0.314	-0.150	-0.105	-0.207	0.008	0.182	0.338*	0.351**	-0.149	-0.053	0.313*	-0.299*	0.094
3	Plant Height			1.000	-0.082	0.266*	0.112	0.395**	0.678**	0.285*	0.241	-0.039	-0.045	0.035	-0.121	-0.012
4	Tillers/ Plant				1.000	0.195	0.287*	0.301*	-0.183	-0.026	-0.092	-0.254	0.364**	0.677**	0.275*	0.734**
5	Flag Leaf Length					1.000	0.415**	0.610**	0.516**	0.154	-0.023	-0.354**	0.363**	0.109	0.342**	0.320*
6	Flag Leaf Width						1.000	0.702**	0.242	0.160	0.010	0.036	0.139	-0.025	0.328**	0.197
7	Spike Length							1.000	0.449	0.363**	0.269**	-0.194	0.242	0.182	0.391**	0.412**
8	Peduncle Length								1.000	0.312*	0.149	0.015	-0.001	-0.224	0.034	-0.134
9	Spikelets/ Spike									1.000	0.850**	-0.194	-0.140	0.290*	0.176	0.384**
10	Grains/ Spike										1.000	-0.153	-0.257	0.319*	0.139	0.380**
11	Days to Maturity											1.000	-0.418**	-0.567**	-0.069	-0.542**
12	1000 Grain Weight												1.000	0.319*	0.314*	0.455**
13	Biological Yield													1.000	-0.069	0.813**
14	Harvest Index														1.000	0.511**
15	Grain Yield/ Plant															1.000

** Significant at 1% level,* Significant at 5% level

TABLE 5: Genotypic Path analysis :direct (diagonal) indirect effect of 15 character on grains yield

No	Character	Days to 50% Heading	Days to 50% Flowering	Plant Height	Tillers/ Plant	Flag Leaf Length	Flag Leaf Width	Spike Length	Peduncle Length	Spikelets / Spike	Grains/ Spike	Days to Maturity	1000 Grain Weight	Biological Yield	Harvest Index	Grain Yield/ Plant
1	Days to 50% Heading	-0.0930	-0.0926	-0.0466	0.0106	0.0123	0.0208	-0.0038	-0.0203	-0.0342	-0.0342	0.0109	0.0113	-0.0318	0.0433	0.0617
2	Days to 50% Flowering	0.0031	0.0031	0.0015	-0.0004	-0.0004	-0.0008	0.0000	0.0006	0.0012	0.0011	-0.0005	-0.0002	0.0011	-0.0014	0.0762
3	Plant Height	0.0002	0.0002	0.0004	0.0000	0.0001	0.0001	0.0002	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	-0.0001	-0.0195
4	Tillers/ Plant	0.0091	0.0110	0.0066	-0.0801	-0.0197	-0.0272	-0.0247	0.0159	0.0043	0.0067	0.0223	-0.0300	-0.0562	-0.0318	0.8106
5	Flag Leaf Length	0.0028	0.0028	-0.0074	-0.0053	-0.0215	-0.0106	-0.0139	-0.0120	-0.0031	0.0002	0.0097	-0.0089	-0.0025	-0.0095	0.3495
6	Flag Leaf Width	0.0147	0.0176	-0.0083	-0.0223	-0.0325	-0.0658	-0.0534	-0.0181	-0.0126	-0.0020	-0.0049	-0.0095	0.0010	-0.0307	0.2297
7	Spike Length	0.0037	0.0011	0.0502	0.0276	0.0579	0.0724	0.0893	0.0406	0.0373	0.0262	-0.0207	0.0216	0.0162	0.0452	0.4454
8	Peduncle Length	0.0122	0.0113	0.0471	-0.0111	0.0312	0.0154	0.0254	0.0560	0.0195	0.0088	0.0001	0.0000	-0.0131	0.0025	-0.1386
9	Spikelets/ Spike	0.0306	0.0327	0.0343	-0.0045	0.0118	0.0160	0.0348	0.0290	0.0833	0.0810	-0.0188	-0.0115	0.0271	0.0161	0.4226
10	Grains/ Spike	-0.0374	-0.0366	-0.0305	0.0085	0.0009	-0.0031	-0.0298	-0.0159	-0.0988	-0.1017	0.0166	0.0264	-0.0335	-0.0117	0.3835
11	Days to Maturity	-0.0026	-0.0037	-0.0008	-0.0062	-0.0100	0.0017	-0.0051	0.0000	-0.0050	-0.0036	0.0222	-0.0101	-0.0137	-0.0018	-0.6111
12	1000 Grain Weight	0.0049	0.0024	0.0025	-0.0150	-0.0165	-0.0058	-0.0097	0.0000	0.0055	0.0104	0.0182	-0.0401	-0.0130	-0.0167	0.4851
13	Biological Yield	0.3457	0.3504	0.0392	0.7105	0.1166	-0.0159	0.1838	-0.2368	0.3287	0.3332	-0.6254	0.3279	1.0114	-0.0511	0.8678
14	Harvest Index	-0.2323	-0.2237	-0.1075	0.1984	0.2193	0.2327	0.2523	0.0219	0.0962	0.0573	-0.0407	0.2080	-0.0252	0.4987	0.4509

TABLE 6: Phenotypic Path analysis: direct (diagonal) indirect effect of 15 character on grains yield

No	Character	Days to 50% Heading	Days to 50% Flowering	Plant Height	Tillers/ Plant	Flag Leaf Length	Flag Leaf Width	Spike Length	Peduncle Length	Spikelets/ Spike	Grains/ Spike	Days to Maturity	1000 Grain Weight	Biological Yield	Harvest Index	Grain Yield/ Plant
1	Days to 50% Heading	-0.0840	-0.0820	-0.0298	0.0110	0.0082	0.0172	-0.0026	-0.0167	-0.0280	-0.0302	0.0081	0.0099	-0.0260	0.0265	0.0783
2	Days to 50% Flowering	0.0751	0.0770	0.0242	-0.0116	-0.0081	-0.0159	0.0006	0.0140	0.0261	0.0270	-0.0114	-0.0041	0.0241	-0.0230	0.0939
3	Plant Height	0.0041	0.0036	0.0115	-0.0009	0.0031	0.0013	0.0045	0.0078	0.0033	0.0028	-0.0004	-0.0005	0.0004	-0.0014	-0.0119
4	Tillers/ Plant	-0.0105	-0.0121	-0.0066	0.0803	0.0157	0.0231	0.0242	-0.0147	-0.0021	-0.0074	-0.0204	0.0292	0.0543	0.0221	0.7340
5	Flag Leaf Length	-0.0032	-0.0035	0.0087	0.0064	0.0329	0.0137	0.0201	0.0170	0.0051	-0.0008	-0.0116	0.0119	0.0036	0.0113	0.3195
6	Flag Leaf Width	-0.0031	-0.0031	0.0017	0.0043	0.0063	0.0151	0.0106	0.0036	0.0024	0.0002	0.0005	0.0021	-0.0004	0.0049	0.1968
7	Spike Length	-0.0003	-0.0001	-0.0035	-0.0027	-0.0054	-0.0063	-0.0089	-0.0040	-0.0032	-0.0024	0.0017	-0.0022	-0.0016	-0.0035	0.4122
8	Peduncle Length	-0.0017	-0.0016	-0.0058	0.0016	-0.0044	-0.0021	-0.0039	-0.0086	-0.0027	-0.0013	-0.0001	0.0000	0.0019	-0.0003	-0.1345
9	Spikelets/ Spike	0.0035	0.0036	0.0030	-0.0003	0.0016	0.0017	0.0038	0.0033	0.0105	0.0089	-0.0020	-0.0015	0.0031	0.0018	0.3841
10	Grains/ Spike	0.0289	0.0282	0.0194	-0.0074	-0.0019	0.0008	0.0217	0.0120	0.0684	0.0804	-0.0123	-0.0206	0.0257	0.0111	0.3801
11	Days to Maturity	0.0030	0.0046	0.0012	0.0079	0.0110	-0.0011	0.0060	-0.0005	0.0060	0.0048	-0.0312	0.0130	0.0177	0.0021	-0.5418
12	1000 Grain Weight	-0.0030	-0.0013	-0.0011	0.0091	0.0091	0.0035	0.0060	0.0000	-0.0035	-0.0064	-0.0105	0.0250	0.0080	0.0079	0.4547
13	Biological Yield	0.2275	0.2303	0.0260	0.4981	0.0799	-0.0185	0.1339	-0.1649	0.2138	0.2349	-0.4176	0.2348	0.7362	-0.0505	0.8126
14	Harvest Index	-0.1580	-0.1499	-0.0609	0.1380	0.1716	0.1645	0.1961	0.0172	0.0880	0.0695	-0.0346	0.1575	-0.0344	0.5015	0.5106

CONCLUSION

On the basis of basis of above findings it can be concluded that genotype NW-1014 x AAI-12 followed by HUW-281 x WR-1451 were identified as a best genotype for grain yield per plant. The difference between PCV and GCV was comparatively low, depicting the little influence of environment on the expression of the characters, which is indicative of high heritability for the characters under study. Correlation coefficient showed significant positive association with biological yield per plant, tillers per plant, 1000 grain weight, spike length, spikelets per spike. Path analysis revealed positive direct effects of harvest index and biological yield per plant on the grain yield per plant, so these characters may be used as selection indices for yield improvement in wheat.

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