Correlation, Path-Coefficient & Genetic Diversity Patter in Wheat *(Triticum Aestivum L.)* Under Rainfed Conditions

Sugandh Chauhan and S.D. Tyagi

Kisan (P.G) College, Simbhaoli, Hapur-245207

Ch. Charan Singh University, Meerut-(U.P.)

Email-ID:sunildutttyagi@yahoo.com

ABSTRACT

An experiment was carried out at Kisan (PG) College, Simbhaoli during rabi season 2021-22 to access the correlation, path-coefficient and genetic variability in 40 morphological diverse accessions of wheat *(Triticum aestivum L.)* under rainfed condition. The analysis of variance showed highly significant differences among the geno types for all the characters. The highest estimates of the phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for grain yield/plant, tillers/plant andbiological yield/plant.Grain yield/plant, biological yield/plant and harvest index showed high heritability coupled with high genetic advance as percent of mean indicating the influence of additive gene effects. Biological yield/plant, harvest index showed positive and significant correlation with grain yield/plant and exerted positive and high direct effect on grain yield/plant. D^2 analysis grouped the 40 genotypes into six clusters. The maximum inter cluster distance was observed between cluster V and VI. Hence, the genotypes belonging to cluster V and VI can be utilized in crop improvement programmes and for the development of high yielding varieties under rain-fed conditions.

INTRODUCTION

Wheat *(Triticum aestivum* L.) of family Poaceae is agronomically and nutritionally most important cereal crop grown worldwide. It is a self pollinated crop and second most important staple food crop of world after rice. Wheat is considered as king of cereals accounting for 20% of human consumption of calories and is an important source of protein, vitamins and minerals. Three species of wheat *i.e. Triticum aestivum, Triticum durum* and *Triticum dicoccum* are presently grown as commercial crop in India. India is the second largest producer of wheat after China. In India wheat occupies an area of 31.05 million hectare with production of about 107.18 million tons during 2019-20 (Anonymous, 2020). Uttar Pradesh is the largest wheat producing state in India and accounts for 33.97% of total area under wheat cultivation in India.

Wheat is widely cultivated in India mainly under irrigated condition; however a large area is covered under rainfed. Out of an estimated 140.3million hectare net cultivated area of the country, 79.44 million hectare (57%) is rainfed, contributing 44% of the total food grain production (Mishra *et al.*, 2014). Hence, the productivity in rainfed region can be enhanced by the development of cultivars that are well adapted to dry conditions. The magnitude of genetic variability present in a population is essential for effective genetic improvement.Correlation and path coefficient analysis provide a better understanding of the association of

different characters with grain yield.The grain yield was positively correlated with biomass yield, harvest index, thousand kernel weight, plant height and number of grains/spike (Khanal *et al.*, 2020). Khokhar *et al.*, (2021) found positive direct effect of days to maturity on grain yield.Singh*et al.*, (2021) reported positive direct effect of biological yield per plant on grain yield. Hence, these traits could be used in breeding for grain yield in bread wheat.

Cluster analysis helps to understand the genetic relation between the genotypes and also facilitate the selection of genetically diverse parents in hybridization programme. Hence, the present investigation was carried out to determine the genetic variability, heritability, genetic diversity anddirect and indirect effects of various characters on grain yield in bread wheat under rainfed conditions.

MATERIALS AND METHODS

The experimental material consisted of forty genotypes of wheat (*Triticum aestivum* L.) (Table 1) were obtained from Indian Institute of Wheat and Barley Research Karnal, Haryana.The experiment was laid in a randomized block design with three replications during winter (*rabi*) 2021-22 under rainfed conditions at Experimental Farm of Kisan (PG) College, Simbhaoli, Hapur (UP). In each replication, the genotypes were evaluated in single row of 3m length with row to row and plant spacing of 25cm and 10cm respectively. During experiment only pre- sowing irrigation was applied to ensure proper seed germination. 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/plant, spike length (cm), number of spikelets/spike, number of grains/spike, 1000-grain weight (g), grain yield/plant(g), biological yield/plant (g) and harvest index (%). Standard statistical procedure were used for the analysis of variance, genotypic and phenotypic coefficient of variation, heritability and genetic advance. The path coefficient analysis was done according to the method by Dewey and Lu (1959). Cluster analysis was done based on Mahalanobis D^2 method (1936).

Table 1. List of genotypes

S. No.		S.No.		S. No.		S. No.	
1.	DBW 88	11.	HUW-468	21.	Lok 01	31.	PBW 1763
2.	DBW-222	12.	HUW-234	22.	PBW-703	32.	PBW-677
3.	DBW-303	13.	K-1006	23.	PBW-723	33.	PBW-34
4.	DBW-187	14.	K-1317	24.	PBW-780	34.	Raj-3765
5.	HD-3059	15	K-0307	25.	PBW-701	35.	Sumai-3
6.	C-306	16.	NIAW-1415	26.	PBW-712	36.	WR-544
7.	HD-3118	17.	NI-5439	27.	PBW-725	37.	DPW-621-50
8.	HD-2824	18.	NW-1014	28.	PBW-698	38.	WH-147
9.	HD-3226	19.	NW-5054	29.	PBW-702	39.	WH-730
10.	HD-3086	20.	NW-2036	30.	PBW-550	40.	WH-1105

RESULTS AND DISCUSSION

Analysis of variance and coefficient of variation : The analysis of variance for different characters is presented in Table 2 indicating significant differences among the geno types for all the characters under study. The estimates of mean, range, 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 indicating the influence of environment on the expression of characters. High PCV and GCV values were observed for grain yield/plant (33.92) and (32.80), tillers/plant (32.76) and (29.96), biological yield/plant (30.19) and (29.46), harvest index (27.31) and (26.09) indicating better opportunity for improvement in these traits through selection.

However, moderate PCV and GCV was observed for grains/spike (14.53) and (14.08), 1000 grains weight (11.86) and (11.61), spike length (9.62) and (7.38), plant height (7.65) and (7.05). The magnitude of PCV ranged from 3.58 for days to maturity to 33.92 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 byMohapatra et al., (2019), Shah et al., (2019), Yadav et al., (2021), Olbana et al., (2021), Prasad et al., (2021), Hassani et al., (2022).

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 (95.85), followed by biological yield/plant (95.22), grains/spike (93.89), grain yield/plant (93.50), harvest index (91.31), days to heading (90.20). High heritability indicated that the characters were least influenced by environmental factors. Fellahi et al., (2013), Devesh et al., (2018), Thapa et al., (2019) and Hayadar et al., (2020) also estimated high heritability for important morphological traits. Lowest heritability was observed for spike length (58.85).

Highest value of expected genetic advance expressed as percent of mean was observed for grain yield/ plant (65.34), biological yield/plant (59.23), tillers/plant (56.44) and harvest index (51.36). High heritability coupled with high genetic advance (per cent of mean) was observed for grain yield/plant, biological yield/ plant and harvest index which suggested that these characters can be considered as favourablefor improvement through selection. Grains/spike and 1000 grain weight showed high heritability coupled with moderate genetic advance while high heritability with low genetic advance was observed for days to heading and days to maturity. Low heritability with low genetic advance values was found for spike length and spikelets/spike indicating slow progress through selection for these characters. Similar findingswere also reported by Arya et al., (2017), Vaghela et al., (2021) and Lamara et al., (2022).

Correlation and path coefficient analysis : Correlation analysis estimates the degree and direction of the relationship between variables and are widely used in breeding selection programs. The phenotypic and genotypic correlation for all the characters is presented in Table 4. Genotypically, the grain yield/plant exhibited highly significant positive correlation with biological yield/plant (0.639), 1000 grain weight (0.467), tillers/ plant (0.466), harvest index (0.428), grains/spike (0.328), spike length (0.278) and plant height (0.269). Harvest index showed negative and highly significant relationship with biological yield/plant (-0.384), tillers/plant (-0.301) and number of spikelets/spike (-0.282). Biological yield/plant exhibited positive and highly significant association with tillers/plant while a negative and highly significant correlation with days to heading and days to maturity at both phenotypic and genotypic level.Similar findings were also reported by Kandel et al., (2017), Ojha et al., (2018), Rathod et al., (2019), Maurya et al., (2020) and Semahegn et al., (2021).

111

Path coefficient analysis measures the direct influence of one variable upon the other and allow partitioning of correlation coefficient into components of direct and indirect effects. Estimates of direct and indirect effect are presented in Table 5 and 6. Genotypic path analysis (Table 5) revealed that biological yield/plant showed maximum direct effect (1.0014) on grain yield/plant followed by harvest index (0.8242). Days to heading, spike length and spikelets/spike also exhibited positive direct effect while days to maturity, plant height, tillers/plant, grains/spike and 1000 grain weight showed negative direct effect on grain yield/plant. Tillers/plant showed maximum indirect effect (0.7594) on grain yield/plant via biological yield/plant. Similar results were also observed by Baye et al., (2020), Elahi et al., (2020), Singh et al., (2021) and Ezici et. al., (2022).

Phenotypic path analysis (Table 6) showed that biological yield/plant had highest positive direct effect (0.9715) on grain yield/plant. Days to heading, plant height, tillers/plant, grains/spike and 1000 grain weight showed negative direct effect on grain yield/plant. Tillers/plant showed maximum indirect effect (0.6795) on grain yield/plant via biological yield/plant.

Table 2. Mean squares from analysis of variance (ANOVA) of eleven characters in forty genotypes of bread wheat

Source of variation	D.F	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	1.88	0.78	0.22	0.36	0.01	0.31	6.16	0.82	0.86	6.40	0.06
Treatment	39	67.57**	42.01**	89.08**	2.28**	1.75**	4.24**	139.22**	32.74**	74.28**	179.19**	7.41**
Error	78	2.36	2.32	5.01	0.14	0.33	0.64	2.96	0.47	1.22	5.51	0.17

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

Table 3. Mean, range, GCV, PCV, Heritability and genetic advance for eleven characters of bread wheat

Genotypes	Mean	Min	Max	GCV (%)	PCV (%)	Heritability (%)	Genetic advance (GA)	GA as % of mean
Days to Heading	74.13	67.00	86.00	6.29	6.62	90.20	9.12	12.30
Days to maturity	110.13	104.33	121.67	3.30	3.58	85.07	6.91	6.28
Plant Height (cm)	75.13	62.49	94.63	7.05	7.65	84.85	10.05	13.37
Tillers per plant	2.82	1.43	5.30	29.96	32.76	83.62	1.59	56.44
Spike length (cm)	9.33	7.14	10.66	7.38	9.62	58.85	1.09	11.66
No of spikelets per spike	17.17	13.13	19.63	6.38	7.90	65.19	1.82	10.60
Grains per spike	47.85	30.10	58.87	14.08	14.53	93.89	13.45	28.11
1000 grain weight (g)	28.26	19.80	32.78	11.61	11.86	95.85	6.62	23.41
Biological yield per plant (g)	16.75	5.94	30.43	29.46	30.19	95.22	9.92	59.23
Harvest index (%)	29.16	12.25	47.60	26.09	27.31	91.31	14.98	51.36
Grain yield per plant (g)	4.74	2.21	8.10	32.80	33.92	93.50	3.09	65.34

Table 4. Genotypic (G) and Phenotypic (P) Correlation Coefficient for Different Characters in Bread Wheat

Characters		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/plant (g)	Harvest index (%)	Grain yield per plant (g)
Days to heading	G	1.000	0.784**	0.168	-0.076	0.228*	0.271**	0.200*	0.280**	-0.065	0.222*	0.099
	P	1.000	0.672**	0.172	-0.075	0.191*	0.200*	0.201*	0.261**	-0.053	0.211*	0.101
Days to maturity	G		1.000	-0.189*	-0.105	0.165	0.234*	0.159	0.199*	-0.102	0.246**	0.099
	P		1.000	-0.144	-0.072	0.137	0.196*	0.146	0.177	-0.097	0.228*	0.098
Plant height (cm)	G			1.000	0.288**	0.298**	0.167	0.087	0.308**	0.427**	-0.112	0.269**
	P			1.000	0.305**	0.387**	0.250**	0.127	0.278**	0.423**	-0.097	0.270**
Tillers per plant	G				1.000	0.250**	0.269**	0.123	0.287**	0.758**	-0.301**	0.466**
	P				1.000	0.266**	0.287**	0.134	0.271**	0.699**	-0.267**	0.427**
Spike length (cm)	G					1.000	0.448**	0.397**	0.461**	0.402**	-0.149	0.278**
	P					1.000	0.550**	0.395**	0.349**	0.363**	-0.085	0.276**
No. of Spikelets per spike	G						1.000	0.449**	0.162	0.440**	-0.282**	0.223*
	P						1.000	0.445**	0.148	0.395**	-0.208*	0.220*
Grains per spike	G							1.000	0.005	0.433**	-0.117	0.328**
	P							1.000	0.013	0.426**	-0.093	0.332**
1000 grain weight (g)	G								1.000	0.352**	0.205*	0.467**
	P								1.000	0.333**	0.195*	0.440**
Biological yield/plant (g)	G									1.000	-0.384**	0.639**
	P									1.000	-0.378**	0.628**

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

113

Table 5. Direct Effect (Bold Values) and Indirect Effect for Different Characters on Grain Yield at Genotypic Level

Characters	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 (%)	R with Grain yield per plant (g)
Days to Heading	**0.0098**	-0.0213	-0.0112	0.0024	0.0104	0.0110	-0.0067	-0.0137	-0.0650	0.1830	0.099
Days to maturity	0.0077	**-0.0271**	0.0126	0.0033	0.0076	0.0095	-0.0053	-0.0097	-0.1020	0.2025	0.099
Plant Height (cm)	0.0017	0.0051	**-0.0667**	-0.0092	0.0136	0.0068	-0.0029	-0.0151	0.4281	-0.0925	0.269**
Tillers per plant	-0.0008	0.0029	-0.0192	**-0.0319**	0.0114	0.0109	-0.0041	-0.0141	0.7594	-0.2484	0.466**
Spike length (cm)	0.0022	-0.0045	-0.0198	-0.0080	**0.0457**	0.0182	-0.0132	-0.0226	0.4027	-0.1231	0.278**
No of spikelets per spike	0.0027	-0.0063	-0.0111	-0.0086	0.0205	**0.0407**	-0.0150	-0.0079	0.4404	-0.2320	0.223*
Grains per spike	0.0020	-0.0043	-0.0058	-0.0039	0.0181	0.0183	**-0.0333**	-0.0003	0.4335	-0.0963	0.328**
1000 grain weight (g)	0.0028	-0.0054	-0.0206	-0.0092	0.0211	0.0066	-0.0002	**-0.0489**	0.3524	0.1688	0.467**
Biological yield per plant (g)	-0.0006	0.0028	-0.0285	-0.0242	0.0184	0.0179	-0.0144	-0.0172	**1.0014**	-0.3162	0.639**
Harvest index (%)	0.0022	-0.0067	0.0075	0.0096	-0.0068	-0.0115	0.0039	-0.0100	-0.3842	**0.8242**	0.428**

Residual effect = 0.0533

114

Table 6. Direct Effect (bold values) and Indirect Effect for Different Characters on Grain Yield at Phenotypic Level

Characters	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 (%)	R with Grain yield per plant (g)
Days to Heading	**-0.0137**	0.0035	-0.0099	0.0017	0.0047	0.0051	-0.0028	-0.0076	-0.0515	0.1713	0.101
Days to maturity	-0.0092	**0.0052**	0.0082	0.0017	0.0034	0.0050	-0.0020	-0.0052	-0.0938	0.1854	0.099
Plant Height (cm)	-0.0024	-0.0008	**-0.0573**	-0.0070	0.0095	0.0064	-0.0018	-0.0081	0.4107	-0.0793	0.270**
Tillers per plant	0.0010	-0.0004	-0.0175	**-0.0229**	0.0065	0.0073	-0.0019	-0.0079	0.6795	-0.2172	0.427**
Spike length (cm)	-0.0026	0.0007	-0.0222	-0.0061	**0.0246**	0.0140	-0.0056	-0.0102	0.3524	-0.0692	0.276**
No of spikelets per spike	-0.0027	0.0010	-0.0143	-0.0066	0.0135	**0.0254**	-0.0062	-0.0043	0.3835	-0.1688	0.220*
Grains per spike	-0.0027	0.0008	-0.0073	-0.0031	0.0098	0.0113	**-0.0140**	-0.0004	0.4139	-0.0760	0.332**
1000 grain weight (g)	-0.0036	0.0009	-0.0159	-0.0062	0.0086	0.0038	-0.0002	**-0.0291**	0.3237	0.1583	0.440**
Biological yield per plant (g)	0.0007	-0.0005	-0.0242	-0.0160	0.0089	0.0100	-0.0060	-0.0097	**0.9715**	-0.3072	0.628**
Harvest index (%)	-0.0029	0.0012	0.0056	0.0061	-0.0021	-0.0053	0.0013	-0.0057	-0.3669	**0.8134**	0.445**

Residual effect = 0.0597

GENETIC DIVERGENCE

On the basis of D^2 values, all the 40 genotypes were grouped in 6 clusters (Table 7). Among the six clusters, cluster III was the largest, comprising of 10 genotypes followed by cluster II with 8 genotypes, cluster I with 7 genotypes, cluster IV with 6 genotypes, cluster V with 5 genotypes and cluster VI with 4 genotypes. The clustering pattern revealed that the groups of genotypes which were together in a cluster also indirectly proved their stable performance.

The inter and intra cluster distance among the genotypes is presented in Table 8. The maximum intra-cluster distance was observed in cluster III (2.342) followed by cluster VI (2.197) and cluster V (2.168) indicating differences in genotypes within the cluster. The least intra-cluster distance was found in cluster I (1.939) indicating close resemblance between the genotypes presented in this cluster. The highest inter-cluster distance was observed between cluster Vand VI (6.059) indicating a high degree of genetic diversity. The lowest inter- cluster distance was observed between cluster II and III (2.413) followed by cluster Iand II (2.655) indicating that these clusters were relatively less divergent.

The cluster mean for each character is tabulated in Table 9. Highest mean values for days to heading (82.50) and days to maturity (116.78) was observed in cluster IV while least mean values for these characters was found in cluster V and VI. Cluster VI exhibited the highest mean values fortillers/plant (4.27), spikelets/ spike (18.22), 1000 grain weight (30.76), biological yield/plant (24.84) and grain yield/plant (6.91). Highest mean values for grains/spike (51.49) and harvest index (34.68) was recorded in cluster IV. Cluster V exhibited lowest mean values for plant height (67.95), tillers/plant (2.23), spike length (7.82), spikelets/spike (15.40) and grains/spike (38.82). Singh *et al.*, (2019), Majid and Dar (2020), Kumar *et al.*, (2021),Tanveer *et al.*, (2021) and Chaudhary *et al.*, (2022) also studied the genetic divergence in bread wheat.

Table 7. Clustering Pattern of 40 Genotypes of Bread Wheat on The Basis of D^2 Statistic

Cluster No.	No. of genotypes	Genotypes in cluster
I	7	DBW 303, HD 3086, HUW 468, NW 1014, NW 2036, PBW 780, WH 147
II	8	K 1317, NIAW 1415, PBW 723, PBW 698, PBW 550, PBW 701, PBW 677, DPW 621-50
III	10	HD 3118, HD 2824, HD 3226, K 1006, K 0307, NI 5439, NW 5054, PBW 34, Sumai 3, WH 730
IV	6	DBW 88, DBW 222, DBW 187, C 306, Lok 01, WH 1105
V	5	HD 3059, HUW 234, PBW 703, PBW 712, WR 544
VI	4	PBW 725, PBW 702, PBW 1763, Raj 3765

Table 8. Inter and Intra-Cluster (Bold Values) Distances Involving Forty Genotypes of Bread Wheat

Clusters	I	II	III	IV	V	VI
I	**1.939**					
II	2.655	**2.080**				
III	2.964	2.413	**2.342**			
IV	4.107	3.693	3.312	**2.167**		
V	3.555	4.948	4.222	5.317	**2.168**	
VI	4.413	2.765	2.953	4.690	6.059	**2.197**

Table 9. Cluster Mean for Eleven Characters in Bread Wheat

Clusters	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)
I	73.19	108.81	74.25	2.45	9.05	17.31	49.02	24.01	15.31	21.97	3.27
II	72.92	109.42	76.06	3.28	10.04	17.85	47.32	30.00	18.72	22.61	4.15
III	73.27	109.00	78.20	2.75	9.57	16.63	49.39	28.56	17.27	34.40	5.86
IV	82.50	116.78	73.77	2.27	9.54	17.81	51.49	30.40	14.84	34.68	5.03
V	70.53	108.73	67.95	2.23	7.82	15.40	38.82	26.26	10.38	33.27	3.38
VI	72.25	108.42	78.15	4.27	9.35	18.22	48.88	30.76	24.84	28.32	6.91

CONCLUSION

From the present study it is concluded that the analysis of variance showed highly significant differences among the genotypes for all the characters studied under rainfed condition. PCV values were higher than GCV values but the difference variability between these two estimates for all the characters was very close. The characters grain yield/plant, biological yield/plant and harvest index were recorded with high heritability and genetic advance values. Correlation analysis showed positive and highly significant association of grain yield with biological yield/ plant followed by thousand grain weight, tillers/plant and harvest index. Cluster analysis revealed highest inter cluster distance between cluster V and VI indicating genetic diversity among the genotypes.

REFERENCES

Anonymous (2020). Directorate of Economics and Statistics, Ministry of Agriculture and Farmer Welfare Government of India.

Arya, V. K., Singh, J., Kumar, L., Kumar, R., Kumar, P., & Chand, P. (2017). Genetic variability and diversity analysis for yield and its components in wheat (Triticum aestivum L.). *Indian Journal of Agricultural Research, 51*(2).

Baye, A., Berihun, B., Bantayehu, M., &Derebe, B. (2020). Genotypic and phenotypic correlation and path coefficient analysis for yield and yield-related traits in advanced bread wheat (Triticum aestivum L.) lines. *Cogent Food & Agriculture, 6*(1), 1752603.

Chaudhary, H., Jaiswal, J.P., Kumar, A.,& Joshi, S. (2022). Determination of of Genetic Variability and Diversity in Bread Wheat for Yield and Yield Contributing Traits. *International Journal of Plant & Soil Science*, 16-23

Devesh, P., Moitra, P. K., Shukla, R. S., Shukla, S. S., Pandey, S., & Arya, G. (2018). Analysis of variability, heritability and genetic advance of yield, its components and quality traits in wheat. *International Journal of Agriculture, Environment and Biotechnology, 17*(4), 855-859.

Dewey, D. R., & Lu, K. (1959). A correlation and path coefficient analysis of components of crested wheatgrass seed production 1. *Agronomy journal, 51*(9), 515-518.

Elahi, T., Pandey, S., & Shukla, R. S. (2020). Genetic variability among wheat genotypes based on Agro-morphological traits under restricted irrigated conditions. *Journal of Pharmacognosy and Phytochemistry, 9*(3), 801-805.

Ezici, A. A., Hýzlý, H., Yaktubay, S., Ay, H., &Oluk, C. A. (2022). Interpretation of Morphological and Quality Characteristics Affecting Yield in Some Bread Wheat (Triticum aestivum L.) Genotypes by Path, Correlation Analysis and Genetic Variability.

Fellahi, Z., Hannachi, A., Guendouz, A., Bouzerzour, H., &Boutekrabt, A. (2013). Genetic variability, heritability and association studies in bread wheat (Triticum aestivum L.) genotypes. *Electronic Journal of plant breeding, 4*(2), 1161-1166.

HASSANI, Ý., NIMBAL, S., SINGH, V., & NOORI, A. (2022). Genetic Variability Analysis and Correlation Studies of Bread Wheat (Triticum aestivum L.) Genotypes. *Ekin Journal of Crop Breeding and Genetics, 8*(2), 139-145.

Haydar, F. M. A., Ahamed, M. S., Siddique, A. B., Uddin, G. M., Biswas, K. L., &Alam, M. F. (2020). Estimation of genetic variability, heritability and correlation for some quantitative traits in wheat (Triticum aestivum L.). *Journal of Bio-Science, 28*, 81-86.

Kandel, M., Bastola, A., Sapkota, P., Chaudhary, O., Dhakal, P., & Chalise, P. (2017). Association and path coefficient analysis of grain yield and its attributing traits in different genotypes of wheat (Triticum aestivum L.). *International Journal of Applied Sciences and Biotechnology, 5*(4), 449-453.

Khanal, D., Thapa, D. B., Dhakal, K. H., Pandey, M. P., & Kandel, B. P. (2020). Correlation and path coefficient analysis of elite spring wheat lines developed for high temperature tolerance. *Environ. Ecosystem Sci, 4*(2), 56-59.

Khokhar, M. I., Hussain, M., Zulkiffal, M., Ahmad, N., &Sabar, W. (2021). Effects of yield components of bread wheat and their suitability in a breeding plan.

Kumar, A., Chand, P., Thapa, R. S., & Singh, T. (2021). Assessment of Genetic Diversity and Character Associations for Yield and Its Traits in Bread Wheat (Triticum aestivum L.). *Indian Journal of Agricultural Research, 1*, 7.

Lamara, A., Benniou, R., Fellahi, Z. E. A., &Hannachi, A. (2022). Assessing the phenotypic variation, heritability and genetic advance in bread wheat (Triticum aestivum L.) candidate lines grown under rainfed semi-arid region of Algeria. *RevistaFacultad Nacional de Agronomia Medellin, 75*(3).

Mahalanobis, P. C. (1936). On the generalized distance in statistics. National Institute of Science of India.

Majid, S., & Dar, Z. A. (2020). Genetic Diversity Analysis for Various Morphological And Quality Traits In Bread Wheat (Triticum Aestivum L.). *Plant Archives, 20*(1), 2816-2819.

Maurya, A. K., Yadav, R. K., Singh, A. K., Deep, A., & Yadav, V. (2020). Studies on correlation and path coefficients analysis in bread wheat (Triticum aestivum L.). *Journal of Pharmacognosy and Phytochemistry, 9*(4), 524-527.

Mishra, C.N., Kumar, S., Meena, R.P., & Gupta, V. (2014). Wheat cultivation in rainfed conditions of India. Pop. Kheti, 2(2): 2-5

Mohapatra, S. S., Priya, B., & Mukherjee, S. (2019). Studies on Variability, Heritability and Genetic Advance in Some Quantitative and Qualitative Traits in Bread Wheat (Triticum aestivum L.) under Rainfed Condition. *Int. J. Curr. Microbiol. App. Sci, 8*(9), 1040-1050

Ojha, R., Sarkar, A., Aryal, A., Rahul, K. C., Tiwari, S., Poudel, M., ... & Shrestha, J. (2018). Correlation and path coefficient analysis of wheat (Triticum aestivum L.) genotypes. *Farm and Management, 3*, 136-141.

Olbana, T. M., Mekbib, F., & Tadesse, W. (2021). Assessment of genetic variability among bread wheat genotypes for agronomic and morphological traits under optimum and stress condition.

Prasad, J., Dasora, A., Chauhan, D., Rizzardi, D. A., Bangarwa, S. K., &Nesara, K. (2021). Genetic Variability, Heritability and Genetic Advance in Bread Wheat (Triticum aestivum L.) Genotypes.

Rathod, S. T., Pole, S. P., & Gawande, S. M. (2019). Correlation and path analysis for quality and yield contributing traits in wheat (Triticum aestivum L.). *International Journal of Current Microbiology and Applied Sciences, 8*(06), 456-461.

Semahegn, Y., Shimelis, H., Laing, M., & Mathew, I. (2021). Genetic variability and association of yield and yield components among bread wheat genotypes under drought-stressed conditions. *Australian Journal of Crop Science, 15*(6), 863-870.

Shah, A. A., Bhat, R. A., Bhat, B. A., & Mondal, S. K. (2019). Genetic evaluation of winter wheat genotypes under rainfed conditions. *IJCS, 7*(1), 1064-1071.

Singh, S. K., Singh, A. K., Singh, M. K., Jaiswal, P., Tigga, A., & Kumar, A. (2019). Genetic Diversity of bread wheat (Triticum aestivum L.) using the multivariate analysis in normal irrigation and drought stress conditions. *Current Journal of Applied Science and Technology, 38*(6), 1-9.

Singh, A., Pandey, J., Singh, S., Singh, R. P., & Singh, R. K. (2021). Correlation and path coefficient analysis for yield and yield attributing traits in advanced bread wheat (Triticum aestivum L.) Lines.

Singh, S., Soni Singh, T., Mourya, S., & Singh, V. (2021). Correlation and path analysis of quantitative traits in different wheat (Triticum aestivum L. Em. Thell) genotypes under reclaimed salt affected soil.

Tanveer, H., Singh, R. K., Singh, S., Singh, H., & Pal, D. (2021). Genetic diversity analysis in bread wheat (Triticum aestivum Linn. Emend Thell.) for yield and its contributing characters. *SKUAST Journal of Research, 23*(2), 145-149.

Thapa, R. S., Sharma, P. K., Pratap, D., Singh, T., & Kumar, A. (2019). Assessment of genetic variability, heritability and genetic advance in wheat (Triticum aestivum L.) genotypes under normal and heat stress environment. *Indian journal of agricultural research, 53*(1), 51-56.

Vaghela, G. K., Patel, J. M., &Rahevar, P. (2021). Assessment of genetic variability and character association for Morpho-Chemical traits in Bread Wheat (Triticum aestivum L.). *Emergent Life Sciences Research, 7*, 14-20.

Yadav, N., Dashora, A., Choudhary, U., Dave, M., & Rathore, J. (2021). Assessment of genetic variability, heritability and genetic advance in bread wheat (Triticum aestivum L.) Genotypes.

■■■