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Variability, character association and path analysis in wheat (*Triticum aestivum* L.)

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Abstract
The present investigation was conducted with the objective to estimate genetic variability, character association and path analysis for yield and yield contributing characters in wheat. The experiment was carried out with 36 wheat genotypes and data were recorded for 13 characters. Highly significant differences among the genotype were revealed by analysis of variance for all the characters. High estimates of variance reflected for plant height, number of grains per spike, harvest index, biological yield and grain yield indicated that they could be considered in selection for improvement of the crop varieties. Correlation analysis revealed that grain yield showed highly significant positive correlation with biological yield while significant positive correlation with tillers per plant. Highly positive direct effect on yield was recorded for number of grains per spike followed by spike length, awn length, plant height and 100 grain weight at genotypic level as revealed by path coefficient analysis. The finding of present investigation might be use full to the future breeding programmes for developing improved genotype. On the basis of study, the desirable donors for each character were identified. The most promising donors for grain yield were WP710/17, HD3189, WP708/17 TALL-1 and PBW343. These genotypes can be used for further breeding programme to improve the yield potential of the variety.

Keywords: Wheat, *Triticum aestivum*, variability, correlation, path analysis

Introduction
Wheat, the 'King of Cereals' is an important staple food of many countries in the world and occupies the prominent position in the international food grain trade. Scientists have traced its origin back to the Middle East region, particularly the valley of Tigris and Euphrates Rivers. India is one of the major producers of wheat and ranks second after China in area and production. In India the total production of wheat was about 98.61 m tones from an area of 29.72 M ha and productivity of 33.18 q/ha during 2017-18. In Uttarakhand the total wheat area was 33 thousand-hectare with a total production of 880 thousand tonne and productivity was 26.43 q/ha during Rabi 2017-18. (Anonymous, 2018) [1].

The development of high yielding wheat cultivars is the main objective of any wheat breeding programmes in the world as well as in India. Improvement in crop depend upon the magnitude of genetic variability in economic characters therefore, the evaluation and utilization of genetic variability in desired direction becomes extremely important in any field improvement programme. In this regard, it is necessary to survey the available useful variability and nature of association among the various plant characters in the basic material. Yield is quantitative character and is governed by many genes having smaller effects i.e., polygenes. Thus, we can say that the yield is the final product of yield components. These components may affect the yield directly or indirectly. Therefore, yield can be maximized by improving the yield components provided there is no unfavourable association. The correlation coefficient gives an idea about the various associations existing between the yield components. The correlation study can show the magnitude of association between any two characters. thus, the knowledge of character association is essential for simultaneous improvement of yield and yield components.

Path analysis reveals the causes of association and their relative significance, whereas correlation simply measure the mutual association. The degree of association among the characters contributing towards economic yield was estimated by the correlation coefficient, hence, its knowledge with regard to grain yield and yield components could be helpful in the selection. However, it does not provide measure of causal relationship exiting among variables. Therefore, it becomes essential to identify the component of yield and their relative contribution. The path coefficient analysis helps in understanding the causal factor better, because it divides total correlation of paired traits into direct and indirect effects via other characters. Therefore, the present investigation had been conducted to estimate extent of variability, to assess the nature and magnitude of inter-character correlation and to estimate the path coefficient for different characters among wheat germplasm lines.

Materials and Methods

Thirty-six improved genotype of bread wheat were evaluated at Research farm of R.M.P. P.G. College, Gurukul Narsan, Haridwar (Uttrakhand) for different morphological traits. The Gurukul Narsan is situated in the foothills of Shivalik range of Himalaya and falls in the humid sub-tropical climate Zone. The Material was planted in a randomized complete block design with three replications under timely sown Condition in the plot consists of 2 row of 2.5 m length spaced at 23 cm. the observations were recorded on a random sample of 10 plants from each plot for 13 quantitative characters viz., Days to emergence, Plant height (cm), No of tillers/plant, Spike length (cm), Awn length (cm), No. of spikelet /spike, No. of grains/spikelet, No. of grains/ spike, Grain weight/ear (gm), 100 grain weight (gm), Biological yield (gm), Harvest Index and Grain yield/plant (gm).

Genetic parameters viz., Mean, Range, Coefficients of variability (PCV and GCV), Correlation and Path coefficient were estimated for the character studied. Analysis of variance permits estimation of phenotypic, genotypic and environmental coefficients of variability. Estimation of different coefficients of variability was done following (Burton 1953) [2]. Correlation coefficients between all possible pairs of characters were calculated at genotypic and phenotypic level. The analysis of variance and covariance was used for the estimation of correlation coefficient as suggested by (Searle 1961) [3]. The phenotypic and genotypic correlation coefficients were further partitioned into direct and indirect effects with the help of path coefficient analysis as suggested by Wright (1921) and explained by (Dewey and Lu 1959) [5].

Results and Discussion

Estimation of Variability parameters

Analysis of variance reviled highly significant differences among the genotypes for all the thirteen characters Viz: days to emergence, plant height, number of tillers per plant, number of tillers per plant, spike length(cm), awn length(cm), number of spikelet per spike, number of grains per spikelet, number of grains per spike, grain weight per ear, 100 grain weight, biological yield, harvest index and grain yield per plant.. The results clearly indicated that sufficient variability was present in the experimental materials for the character studied. The magnitude of variance for any trait in the population is of great importance to a plant breeder for starting a breeding programme. Characters with high estimates of variance like plant height, harvest index, biological yield and grain yield can be considered in selection for improvement of the crop species. The general mean, range of variation, Genotypic (GCV), Phenotypic (PCV) and Environmental (ECV) coefficient of variation for different characters are given in Table 1.

Critical perusal of the Table 1 indicated that the days of emergence ranged from 15.00-17.00 with general mean 15.65 and genotypic coefficient of variation 2.22 percent. Plant height ranged from 71.53 cm to 180.00 cm with general mean 87.33 cm and genotypic coefficient of variation 13.21 percent. The genotype WP703/17 attained maximum height and genotype DBW 17 attained minimum height. Number of tillers per plant showed wide range from 4.33 to 9.00 tillers per plant with general mean 6.62 and genotypic coefficient of variation 13.88 percent. The genotype PBW 154 attained maximum number of tillers followed by WP 703/17 and genotype PBW 530 attained minimum number of tillers. Spike length ranged from 7.47 cm. to 13.27 cm with general mean 9.79 cm and genotypic coefficient of variation 12.93 percent. The genotype WP703/17 attained maximum spike length followed by Raj 4037 and genotype PBW 292 attained minimum spike length. Awn length exhibited range of variation from 4.70 cm. to 10. 33 cm with general mean 6.86 cm and genotypic coefficient of variation 21.91 percent. The genotype WP703/17 attained maximum awn length and genotype PBW 660 attained minimum awn length. The range found for number of spikelets per spike was 17.00 to 23.67 with general mean 19.56 and genotypic coefficient of variation 6.87 percent. The genotype Tall-1 attained maximum number of spikelets followed by WP 710/17 and genotype PBW 292 attained minimum number of spikelets per spike.

The mean number of grains per spikelet ranged from 3.00 to 3.66 with general mean 3.10 and genotypic coefficient of variation 3.19 percent. The genotype DBW 95 attained maximum number of grains per spikelet. The mean number grains per spike ranged from 36.33 to 82.00 with general mean 59.46 and genotypic coefficient of variation 16.29 percent. The genotype WHD 945 attained maximum number of grains per spike and genotype PBW 292 attained minimum number of grains. Grain weight per ear exhibited range of variation 1.88 g to 4.01 with general mean 2.78 and genotypic coefficient of variation 17.88 percent. The genotype WHD 945 attained maximum grain weight and genotype PBW 292 attained minimum grain weight. The mean 100 grain weight ranged from 3.92 to 5.28 with general mean 4.58 and genotypic coefficient of variation 8.72 percent. The genotype WP703/17 attained maximum 100 grain weight followed by WP 711/17, Raj 4037, PBW 726 and WHD 945. The genotypes DBW 17 attained minimum 100 grain weight.

Biological yield showed range of variation 18.53 to 86.00 with general mean 30.91 and genotypic coefficient of variation 35.03 percent. The genotype MAHYCO GOAL attained maximum biological yield and genotype WHD 945 attained minimum biological yield. The harvest index ranged from 19.93 to 82.00with general mean 49.66 and genotypic coefficient of variation 20.97 percent. The genotype WHD 945 attained maximum harvest index and genotype MAHYCO GOAL attained minimum harvest index. The mean grain yield per plant ranged from 10.26 to 21.26 with general mean 14.61and genotypic coefficient of variation 18.19 percent. The genotype WP 710/17 attained maximum grain yield per plant followed by HD 3189 and PBW 530. The genotype PBW 292 attained minimum grain yield. These results are also in agreement with the findings of Kumar *et al* 2008 [6, 18], Chavda *et al* 2013 [7, 9], Kumar *et al* 2013 [8, 9], Rashidi *et al.* (2013) [10], Abd El Mohsen *et al.* (2014) [11] and Dutamo (2015) [12].

Revealing Character associations among yield components

Complex character like Grain yield is the end product of multiplicative interaction between the various yield components, hence, earlier workers had emphasized significance of components approach in forming a successful breeding programme. An idea about the various associations between yield and yield contributing components can be revealed through the correlation coefficient. The correlation coefficients among different characters were worked out and are presented in Table 2. Association studies revealed that grain yield showed highly significant positive correlation with biological yield and significant positive correlation with harvest index and number of tillers per plant. Harvest index exhibited highly positive correlation with number of grains per spikelet however it showed highly significant negative correlation with biological yield. Hundred grain weight showed highly significant positive correlation with grain weight per ear. Grain weight per ear showed highly significant positive correlation with number of grains per spike, number of spikelets per spike, awn length and spike length. Number of grains per spike showed highly positive correlation with number of spikelets per spike while significant correlation with awn length however it showed significant and negative correlation with tiller per plant. Number of grains per spikelet showed significant negative correlation with plant height. Number of spikelets per spike showed highly significant and positive correlation with spike length and plant height. With respect to Awn length data showed significant positive correlation with days to 75% flowering.

Experimental findings of the present investigation revealed positive relationship between yield and its components such as biological yield, harvest index and number of tillers per plant which reflects promise of grain yield in new genotype as a result of appropriate selection of component genes of desired value. Similar relationship were recorded by Bhushan *et al.* (2013) [13], Kumar *et al.* (2014) [14] and Gholozadeh and Dehghani (2015) [15]. Meena, *et al.* (2014) [16] reported positive association between Grain Yield and 1000-grain weight, while Patel *et al.* 2015 [17] found positive correlation of Grain Yield with Number of grains per ear

Harvest Index showed highly significant and positive correlation with number of grains per spikelet. Similar observation recorded by Kumar *et al.* (2014) [14]. 100 grain weight showed highly significant positive correlation with grain weight per ear. Grain weight per ear also showed highly significant and positive correlation with number of grains per spike, number of spikelets per spike awn length and spike length. Number of grains per spike showed highly significant and positive correlation with number of spikelets per spike while it showed significant positive correlation with awn length. Number of grains per spikelet showed significant negative correlation with plant height. Number of spikelets per spike also showed highly significant positive correlation with spike length and plant height. Similar relationship was recorded Similar results were obtained earlier workers as reported by **(**Kumar *et al.* 2008, Tsegaye *et al.* 2012 and Vikas *et al.* 2013) [6, 18, 9, 20].

Path analysis for understanding interrelationships

The direct and indirect effect of yield contributing character on yield at genotypic level has been presented in Table 3. The experimental data showed that highest positive direct effect on yield was recorded for number of grains per spike (4.604) followed by grain yield per plant (1.679), spike length (1.069), awn length (0.851), plant height (0.7654) and 100 grain weight (0.679) at genotypic level. However, direct negative effect on yield was recorded for grain weight per ear (–4.702) followed by number of grains per spikelet (–1.298), number of spikelet per spike (–0.958), number of tiller/plant (–0.688) harvest index (–0.347) and days to emergence (–0.120).

Positive indirect effects of days to emergence on grain yield was recorded via number of grains per spike (0.428) followed by awn length (0.323). Spike length (0.284), 100 grain weight (0.210) and plant height (0.165), while indirect negative effect of days to emergence on yield was caused via grain weight per ear (–0.978) followed by number of spikelet per spike (0.116). Highest positive indirect effect on yield via plant height was exhibited by number of grains per spike (0.529) followed by spike length (0.307), biological yield (0.247), while highest negative indirect effect via plant height on yield was exhibited by grain weight per ear (–0.785) followed by number of grains per spikelet, number of spikelet per spike, number of tillers per plant, harvest index and days to emergence. Indirect positive effect on yield via number of tillers per plant was recorded high for number of grains per spike (1.828) followed by biological yield, (0.485) plant height (0.143) and spike length, (0.139). The indirect negative effect on grain yield via spike length was recorded for grain weight per ear (–2.031) followed by spikelet per spike (–0.532) and Grains per spikelet (–0.117). Indirect highest effect on yield via awn length recorded for grains per spike (1.538) followed by 100 grain weight (0.169) and spike length (0.130). The highest negative effect on grain yield via awn length was recorded for grain weight per ear (–2.026) followed by grains per spike (-0.409), tiller per plant (–0.261) and spikelets per spike (–0.104).

At genotypic level highest indirect positive effect on yield via spikelet per spike was recorded for grains per spike (3.177) followed by spike length (0.593), plant height (0.304) and awn length (0.268), while the highest indirect negative effect on yield via spikelet per spike recorded for grain weight per ear. (–3.023) followed by grain per spike (–0.357) and tillers per plant (–0.100). Indirect positive effect on yield via grains per spikelet was recorded high for grains per spike (0.0967) following by biological yield (0.524) and plant height (0.314). Indirect highest negative effect on yield via grains per spike was recorded for grain per spikelet (–0.264) followed by harvest index (–0.227). Indirect positive effect on yield via grain per spike was recorded high for awn length (0.284) followed by plant height (0.269), 100 grain weight (0.162) and biological yield (0.121), while highest indirect negative effect on yield via grains per spike was recorded for grain weight per ear (–4.236) followed by spikelet per spike (–0.273). Highest indirect positive effect on yield via grain weight per ear was recorded for grains per spike (4.148) followed by spike length (0.462), awn length (0.367), biological yield (0.344), 100 grain weight (0.297) and plant height (0.128), while indirect highest negative effect on yield via grain weight per ear was recorded for spikelet per spike (–0.616) followed by tillers per plant (–0.184). Indirect positive effect on grain yield via 100 grain weight was recorded highest for grain per spike (1.073) followed by spike length (0.329) awn length (0.207) and biological yield (0.181), while indirect negative effect on yield via 100 grain weight recorded higher for grain weight per ear (–2.003) following by spikelet per spike (–0.260). Highest indirect positive effect on yield via biological yield was recorded for grains per spike (0.331) followed by spike length (0.160) and plant height (0.112). The indirect negatives effect on yield via biological yield was recorded for grain weight per ear (–0.964) followed by grains per spikelet (–0.405), tillers per plant (–0.199) and spikelet per spike (–0.157). Indirect positive effect on yield via harvest index was recorded highest for biological yield (1.039) followed by grain per spike (0.783), awn length (0.228), plant height (0.192) and spike length (0.125), while indirect negative effect on grain yield via harvest index was recorded higher for grains per spikelet (–0.849) followed by grain weight per ear (–0.724) and tillers per plant (–0.192). Similar results were also observed by Singh *et al.* (2009) [21] and Abd El-Mohsen *et al.* (2014) [11] for grain yield and its various component characters.

The knowledge of such relationships has direct bearing on the selection, and if this knowledge is applied appropriately to the selection, the gain per selection cycle may be much higher as compared to selection of new genotypes randomly. It may not only help in picking up new desirable genotype but it may also reduce the selection pressure. However, totally dependence on such relationship for selection may mislead and end up with the poor selection with change in material and environment. Hence, selection should not be entirely based on such knowledge until and unless the relationship is confirmed. On the basis of study the desirable donors for each character were identified. The most promising donors for grain yield were WP710/17, HD3189, WP708/17 TALL-1 and PBW343. These genotypes can be used for further breeding programme to improve the yield potential of wheat.

Table 1: Mean, range of variation, Genotypic (GCV), Phenotypic (PCV) and Environmental (ECV) coefficient of variation for different characters.

Characters	**General mean**	**Range of variation**	**Coefficient of variation**		
			GCV	**PCV**	**ECV**
Days to emergence	15.65	15.00-17.00	2.22	4.43	3.83
Plant Height (cm)	87.33	71.53-140.0	13.21	13.34	1.84
Number of tillers per plant	6.62	4.33-9.00	13.88	17.25	10.23
Spike length(cm)	9.79	7.47-13.27	12.93	13.12	2.24
awn length(cm)	6.86	4.70-10.33	21.98	22.67	5.53
Number of spikelets per spike	19.56	17.00-23.67	6.87	7.84	3.76
Number of grains per spikelet	3.10	3.00-3.66	3.19	9.74	9.20
Number of grains per spike	59.46	36.33-82.00	16.29	17.35	5.96
Grain weight/ear (gm)	2.78	1.88-4.01	17.88	21.27	11.51
100 grain weight (gm)	4.58	3.92-5.28	8.72	8.77	0.94
Biological yield (gm)	30.91	18.53-86.00	35.03	35.67	6.76
Harvest Index	49.66	19.93-82.29	20.97	24.48	12.61
Grain yield/plant (gm)	14.61	10.26-21.26	18.19	20.75	9.98

Table 2: Genotypic (G) and Phenotypic (P) Correlation coefficient exhibiting interrelationship among the different characters in wheat

Characters		**Days to emergence**	**Plant height**	**Tillers per Plant**	**Spike length**	**Awn length**	**Spikelet per Spike**	**Grain per spikelet**	**Grain per spike**	**Grain weight per ear**	**100 Grain weight**	**Biological yield**	**Harvest Index**	**Grain yield per plant**
Days to emergence	G	1.000	–0.216	–0.047	0.266	0.380*	0.121	–0.031	0.093	0.208	0.301	–0.016	0.135	0.105
	P		–0.118	–0.049	0.120	0.149	0.022	–0.053	0.033	0.114	0.142	0.002	0.025	0.008
Plant high	G		1.000	0.189	0.287	0.090	0.397*	–0.410*	0.115	0.167	0.066	0.147	–0.251	0.030
	P			0.155	0.277	0.086	0.345*	–0.171	0.087	0.128	0.065	0.146	–0.206	0.036
Tillers per Plant	G			1.000	0.130	0.038	–0.145	0.102	-0.397*	–0.267	–0.031	0.289	–0.287	0.331*
	P				0.095	0.029	–0.138	0.016	–0.278	–0.180	–0.012	0.237	–0.181	0.268
Spike length	G				1.000	0.122	0.555**	–0.090	0.252	0.432**	0.308	0.150	–0.117	0.178
	P					0.126	0.489**	0.018	0.255	0.371*	0.299	0.140	–0.114	0.128
Awn length	G					1.000	0.109	–0.315	0.334*	0.431**	0.243	–0.044	0.268	0.127
	P						0.087	–0.105	0.310	0.385*	0.231	–0.043	0.218	0.104
Spikelet per Spike	G						1.000	0.275	0.690**	0.643**	0.271	0.164	0.007	0.176
	P							0.103	0.627**	0.559**	0.240	0.133	0.071	0.179
Grain per spikelet	G							1.000	0.210	–0.008	–0.068	0.312	0.654**	0.316
	P								0.194	0.111	–0.028	0.067	0.084	0.072
Grain per spike	G								1.000	0.901**	0.233	0.072	0.170	0.016
	P									0.805**	0.026	0.058	0.173	0.032
Grain weight per ear	G									1.000	0.426**	0.205	0.154	0.156
	P										0.356*	0.154	0.152	0.126
100Graing weight	G										1.000	0.108	0.014	0.125
	P											0.106	0.017	0.117
biological yield	G											1.000	–0.619**	0.455**
	P												–0.571**	0.396*
Harvest Index	G												1.000	0.237*
	P													0.379
Grain yield per plant	G													1.000
	P													1. 000

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

Table 3: Direct (diagonal) and indirect (off-diagonal) effects of various yield components on yield in Wheat at genotypic level

Characters	Days to 75% emergence	Plant height	Tillers per Plant	Spike length	Awn length	Spikelets per Spike	Grain per spikelet	Grain per spike	Grain weight per ear	100 Grain weight	Biological yield	Harvest Index	Corr. with yield
Days to 75% emergence	-0120	0.165	-0.032	0.284	0.323	-0.116	-0.040	0.428	-0.978	0.210	0.027	-0.047	0.135
Plant high	-0.026	0.765	-0.130	0.307	0.077	-0.380	-0.532	0.529	-0.785	0.046	0.247	-0.087	-0.251
Tillers per Plant	-0.006	0.145	-0.688	0.139	0.032	-0.139	-0.132	1.828	-1.255	0.022	0.485	-0.099	-0.287
Spike length	-0.032	0.220	-0.089	1.069	0.104	-0.532	-0.117	1.160	-2.031	0.215	0.252	-0.041	-0.117
Awn length	-0.046	0.069	-0.261	0.130	0.851	-0.104	-0.409	1.538	-2.026	0.169	0.074	-0.093	0.268
Spikelet per Spike	-0.014	0.304	-0.100	0.593	0.093	-0.958	-0.357	3.177	-3.023	0.189	0.275	-0.002	0.007
Grain per spikelet	-0.004	0.314	-0.070	0.096	0.268	-0.264	-1.298	0.967	-0.038	0.047	0.524	-0.227	0.654
Grain per spike	-0.011	0.088	-0.273	0.269	0.284	-0.661	-0.273	4.604	-4.236	0.162	0.121	-0.059	0.170
Grain weight per ear	-0.025	0.128	-0.184	0.462	0.367	-0.616	-0.010	4.148	-4.702	0.297	0.344	-0.053	0.154
100Grain weight	-0.036	0.050	-0.021	0.329	0.207	-0.260	-0.088	1.073	-2.003	0.697	0.181	-0.005	0.014
Biological yield	-0.002	0.112	-0.199	0.160	0.037	-0.157	-0.405	0.331	-0.964	0.075	1.679	-0.215	-0.619
Harvest Index	-0.016	0.192	-0.197	0.125	0.228	-0.007	-0.849	0.783	-0.724	0.010	1.039	-0.347	0.237

References

1. Anonymous. Progress report of All India Coordinated Wheat and Barley Improvement 2018, Director's report of AICRP on Wheat and Barlay 2017-18. Ed. G.P. Singh, Indian Institute of Wheat and Barley Research, Kernal, India, 2018, 94.
2. Burton GW. Quantitative inheritance in grasses. Proc. Int. Grassland Congr. 1953; 1:277-283.
3. Searle SR. Phenotypic, genotypic and environmental correlations. Biometrica. 1961; 17:475-480.
4. Wright S. Correlation and causation. J. Agric. Res., 1921; 20:557-585.
5. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal. 1959; 51(9):515-518.
6. Kumar S, Malik SS, Jeena AS, Malik SK. Pattern of genetic parameters in early generation selection in wheat (*Triticum aestivum* L.). Int. J Plant Sci. 2008; 3(2):613-616
7. Chavda VS, Kumar S, Jeena AS, Kumar A, Dhama SK, Prasad J *et al*. Genetic variability and response to selection in bread wheat (*Triticum aestivum* L. Em., Thell.). Progressive Research. 2013; 8(Special):263-266
8. Kumar A, Vikas, Kumar S, Jeena AS, Upreti MC, Kushwah PS. Genetic variability, heritability and genetic advance in bread wheat (*Triticum aestivum* L. Em., Thell.). Progressive Research. 2013; 8:273-275
9. Kumar A, Kumar S, Dhama SK, Jeena AS, Chavda VS, Kumar B. Studies on genetic variability in bread wheat (*Triticum aestivum* L. Em., Thell.). Progressive Research. 2013; 8:281-285
10. Rashidi V, Tarinejad AR, Kazemiarbat H. Genotypic variation of spikes' related traits and path analysis of grain yield in durum wheat lines. African journal of Agricultural Research. 2013; 8(16):1559-1562.
11. Abd El-Mohsen AA, Abd El-Shafi MA. Regression and path analysis in Egyptian bread wheat. Journal of Agri-Food and Applied Sciences. 2014; 2(5):139-148.
12. Dutamo D, Alamerew S, Firdisa Eticha F, Assefa F. Path Coefficient and Correlation Studies of Yield and Yield Associated Traits in Bread Wheat (*Triticum aestivum* L.) Germplasm. World Applied Sciences Journal 2015; 33(11):1732-1739.
13. Bhushan B, Bharti S, Ojha A, Pandey M, Gourav SS, Tyagi BS *et al*. Genetic variability, correlation coefficient and path analysis of some quantitative traits in bread wheat. J Wheat Res. 2013; 5(1):24-29.
14. Kumar R, Bhushan B, Pal R, Gaurav SS. Correlation and path coefficient analysis for quantitative traits in wheat (*Triticum aestivum* L.) under normal condition. Annals of Agri-Bio Research. 2014; 19(3):447-450.
15. Gholizadeh A, Dehghani H. Correlation and sequential path analysis between yield and related characters of wheat (*Triticum aestivum* L.) genotypes in non-stressed and salinity-stressed conditions. Romanian Agricultural Research, 2015, 32. DII 2067-5720 RAR 2015-63.
16. Meena HS, Kumar D, Prasad SR. Genetic variability and character association in bread wheat (*Triticum aestivum* L.). Indian J. Agr. Sci. 2014; 84(4):487-491.
17. Patel DD, Moitra PK, Shukla RS. Genetic variability, correlation and path coefficient analysis in wheat (*Triticum aestivum* L.). Frontiers in crop improvement journal, 2015; 3(1):25-28.
18. Kumar S, Malik SS, Jeena AS, Malik SK. Interrelationship among the yield attributes and intergeneration Correlation as a mean of testing effectiveness of early generation testing in wheat (*T. aestivum* L.). Progressive Research. 2008; 3(1):25-30
19. Tsegaye D, Dessalegn T, Dessalegn Y, Share G. Genetic variability, correlation and path analysis in durum wheat germplasm (*Triticum durum* Desf). Agricultural Research and Reviews. 2012; 1(4):107-112.
20. Vikas, Kumar A, Kumar S, Jeena AS, Prasad J, Upreti MC. Genetic variability and character association in bread wheat (*Triticum aestivum* L. Em., Thell.). Progressive Research. 2013; 8:289-291
21. Singh D, Singh SK, Singh KN. Diversity of salt resistance in a large germplasm collection of bread wheat (*Triticum aestivum* L.) Crop Improvement. 2009; 36(1):9-12.