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Study on correlation for quantitative and some quality traits in bread wheat (*Triticum aestivum* L.)

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Abstract
Wheat (*Triticum aestivum* L.) is one of the most important cereals grown in different environments due to its versatile nature over the world and plays a key role in the food and nutritional security of India. The objective of this study was to establish the inter-relationship effect of various wheat components on yield. During *Rabi* 2019-2020 100 treatment parental (10 parents, 45 F_1s and F_2s) followed by diallel mating design were studied for correlation analysis of some quantitative and quality traits in wheat. The experiment was carried out at Crop Research Farm, Nawabganj of C.S.A. University of Agriculture and Technology Kanpur, Uttar Pradesh 208002 (INDIA). Generally, the estimates of genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients for all the character. Grain yield per plant exhibited positive and highly significant relationship with number of productive tiller per plant, spike length, number of spikelets per spike, 1000 grain weight and harvest index at phenotypic levels. While plant height, biological yield per plant and lysine content observed positive and significant correlation with grain yield per plant.

Keywords: Association, correlation, *Triticum aestivum*

Introduction
Wheat (*Triticum aestivum* L. em. Thell.,) is a highly self-pollinated annual cereal crop. It is a member of family Gramminae (Poaceae) and a hexaploid with 42 chromosomes number. Wheat has perfect hermaphrodite flower and sexually autogamous crop. Its domestication was started from the fertile areas of Middle East, and later became one of the most important food crops of the human population of the entire globe. Wheat is an elegant source of nutrients and energy containing major constituents of the food i.e., vitamins particularly riboflavin, thiamine, niacin and vitamin E. Wheat is enriched by protein and carbohydrates and vital minerals such as phosphorus, magnesium, copper, iron and zinc, and about 36% of the world human population uses wheat as staple food (Bhanu *et al*., 2018) [3].
Wheat (*Triticum aestivum* L.) is one of the most important cereal crop grown in different environments due to its versatile nature over the world. At global level, it was cultivated over 221.18 million ha and production of 774.74 million tonnes with an average productivity of 35 quintals per hectare. In India, it is grown in area of 31.36 million hectares with a production of 107.86 million tones and productivity of 34.4 quintals per hectare (USDA, 2021) [15].
Correlation analyses would assist in the choice of characters whose selection would result in the improvement of a complex character such as yield. Correlation estimates the degree of association between variables (Akanda & Mundit 1996) [2]. All possible correlation coefficient among 15 characters were calculated at genotypic and phenotypic level following the procedure of Searle (1965) [11].

Material and Methods
The present experiment work carried out at Crop Research Farm, Nawabganj, CSAUA&T Kanpur, (U.P.) during *Rabi* 2019-20. The experimental material consist of 100 treatments (10 parent, 45 F_1 and 45 F_2) was grown in RCBD (Randomized Complete Block Design) with three replications followed by one line of parent and F_1s, two line of F_2s. The length of each line was 3 m. with line to line and plant to plant spacing of 22.5 and10 cm. Recommended dose of fertilizer i.e. NPK @ 120:60:40 kg ha^{-1} were applied. The mature material was harvested and threshed in the end of April and first week of May 2020.
The formula was used for calculating the genotypic and phenotypic coefficient of correlation

in both the experiments as suggested by Al-Jibouri *et al*. (1958) [1]. The significance of phenotypic correlation coefficients was tested against 'r' values from 'r' table of Fisher and Yates (1938) [4] for (n-2) degree of freedom, where 'n' is the number of treatments.

Results and Discussion

The analysis of variance for all the 15 traits was carried out for testing the significance of differences among the treatments. The mean squares for all the characters. Highly significant differences were observed among the progenies for all the 15 traits except for spike length.

Breeding for high yield is the major objective in any crop improvement programme. A direct selection for yield is often misleading as the yield, besides being polygenically controlled, is subjected to the effect of fluctuating environmental components. An efficiency of selection mainly depends on the knowledge of association of characters with yield and among themselves. The simultaneous expression of characters may be either due to pleiotropy or genetic linkage. If the relationship is due to the manifold effect of a gene(s), it is difficult to separate these effects by selecting a particular characters so related. If the correlation is due to genetic linkage, it is possible to reverse the association, provided the linkage is not very close. It is, therefore, important to establish the genetic basis of correlation before launching any breeding programme. The component characters of yield exhibit different associations among themselves and also with yield. Any unfavourable association between the desirable characters may lead to limited genetic advance. Therefore, it is very essential to have knowledge of the association between yield and its related traits and among themselves in order to plant a sound breeding programme.

In present investigation Table 2(a) and 2(b), the correlation coefficients were estimated among 15 characters at genotypic and phenotypic levels in parent, F_1, and F_2 generations.

Grain yield per plant exhibited positive and highly significant relationship with number of productive tiller plant, spike length, number of spikelets per spike, 1000 grain weight and harvest index at phenotypic levels. Similar findings were earlier reported by Singh (2001) [13] for harvest index. Muhammad *et al*. (2004) [9] for spike length, number of spikelets per spike and 1000 grain weight, Majumder *et al* (2008) [8] for spike length, 1000 grain weight and harvest index and Gaurav *et al*. (2014) [5] for1000 grain weight**.** While plant height, biological yield per plant and lysine content observed positive and significant correlation with grain yield per plant. Emphasis on selection in favour of these traits would help breeders for having desirable correlated response for higher productivity. Similar findings were earlier reported by Kumar *et al*. (2013) [7] for plant height and Ozukum (2019) [10] for biological yield per plant**.**

Number of productive tiller per plant observed positive and highly significant correlations withS, days to maturity, plant height, spike length, number of spikelets per plant, number of grains per spike, biological yield per plant and grain yield per plant at phenotypic level while 1000 grain weight, seed hardness and lysine content associated with positive and significance correlation with number of productive tiller per plant at phenotypic level.

Biological yield per plant showed positive and significant correlations with days to flower (75%), days to maturity, plant height, number of productivity tiller per plant, number of grains per spike, 1000 grain weight, seed hardness and grain yield per plant at phenotypic level while harvest index exhibited negative and highly significant association with biological yield per plant at phenotypic level. Harvest index exhibited positive and highly significant correlations with spike length, number of spikelets per spike, number of grains per spike, biological yield per plant, 1000 grain weight and grain yield per plant at phenotypic level and seed hardness showed negative and highly significant correlation associated with harvest index at phenotypic level. days to flower (75%), days to maturity and number of productive tiller per plant showed positive and highly significant correlations with harvest index at phenotypic level**.** Protein content observed positive and significant correlation with days to flower (75%), days to maturity, number of spikelets per spike, 1000 grain weight and seed hardness at phenotypic level. Days to maturity observed positive and significant correlations with days to flower (75%), plant height, number of productive tiller, number of spikelets per spike, number of grains per spike, biological yield per plant, 1000 grain weight, seed hardness and protein content at phenotypic level. It was expected because a late maturity by plant would allow enough time for plant to conserve more moisture and nutrients and develop more biomass.

Grain yield per plant exhibited positive relationship with days to flower (75%), days to maturity, number of grains per spike, seed hardness, and protein content. Selection for these traits might lead to higher productivity.

Table 1(a): Estimates of genotypic correlation coefficient for 15 characters of 10 parent diallel cross set of wheat

Characters	Days to flower (75%)	Days to Maturity	Plant height (cm)	No of productive tillers / plant	Spike length (cm)	Number of spikelets per spike	No. of grains per spike	Biological yield per plant (g)	1000 grain weight (gm)	Harvest index (%)	Seed Hardnees (kg)	Protein content (%)	Lysine content (%)	Tryptophane content (%)	Grain yield per plant (g)
Days to flower (75%)	1.000	0.913**	0.219**	0.447**	-0.031	0.136*	0.265**	0.339**	0.151**	-0.128*	0.160**	0.174**	0.164**	-0.037	0.114*
Days to maturity			0.163**	0.412**	-0.114*	0.173**	0.290**	0.318**	0.189**	-0.121*	0.194**	0.257**	0.115*	-0.059	0.097
Plant height				0.308**	0.061	0.029	0.097	0.217**	0.034	-0.087	-0.041	-0.083	0.122*	-0.069	0.125*
Number of productive tillers / plant					0.218**	0.210**	0.247**	0.514**	0.145*	-0.099	0.225**	0.064	0.198**	-0.024	0.411**
Spike length						0.312**	0.167**	0.116*	0.032	0.173**	0.220**	-0.041	0.088	0.067	0.328**
Number of spikelets /spike							0.273**	0.063	0.070	0.120*	0.299**	0.231**	0.400**	0.139*	0.213**
Number of grains /spike								0.380**	0.307**	-0.212**	0.364**	0.123*	0.004	-0.121*	0.100
Biological									0.250**	-0.630**	0.338**	0.033	0.151**	-0.071	0.140*

yield /plant (g)															
1000- Grain weight										0.015	0.253**	0.261**	-0.084	-0.012	0.248**
Harvest index											-0.192**	0.072	0.040	0.024	0.651**
Seed Hardnees												0.300**	0.238**	-0.018	0.111
Protein													-0.032	-0.004	0.094
Lysine														0.206**	0.172**
Trytophene															-0.020
Grain yield / plant (g)															1.000

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

Table 1(b): Estimates of phenotypic correlation coefficient for 15 characters of 10 parent diallel cross set of wheat

Characters	Days to flower (75%)	Days to Maturity	Plant height (cm)	No. of productive tillers / plant	Spike length (cm)	No. of spikelets per spike	No. of grains per spike	Biological yield per plant (g)	1000 grain weight (gm)	Harvest index (%)	Seed Hardnees (kg)	Protein content (%)	Lysine content (%)	Tryptophane content (%)	Grain yield per plant (g)
Days to flower (75%)	1.000	0.822**	.0.196**	0.367**	-0.014	0.129*	0.232**	0.323**	0.142*	-0.118*	0.129*	0.116*	0.118*	-0.053	0.107
Days to maturity			0.138*	0.295**	-0.049	0.166**	0.275**	0.291**	0.173**	-0.115*	0.142*	0.183**	0.103	0.043	0.079
Plant height				0.245**	0.037	0.007	0.082	0.208**	0.032	-0.082	-0.038	-0.087	0.087	-0.055	0.114*
Number of productive tillers per plant					0.152**	0.159**	0.171**	0.409**	0.139*	-0.042	0.119*	00.071	0.143*	-0.018	0.377**
Spike length						0.465**	0.219**	0.096	0.031	0.137*	0.189**	-0.012	0.067	0.065	0.259**
Number of spikelets /spike							0.283**	0.065	0.063	0.090	0.207**	0.145*	0.278**	0.107	0.170**
Number of grains /spike								0.352**	0.296**	-0.191**	0.297**	0.110	0.001	-0.099	0.087
Biological yield /plant (g)									0.244**	-0.607**	0.267**	0.021	0.113	-0.061	0.131*
1000- Grain weight										0.043	0.203**	0.221**	-0.063	-0.004	0.271**
Harvest index											-0.150**	0.073	0.038	0.022	0.665**
Seed Hardnees												0.232**	0.109	-0.011	0.073
Protein													-0.010	-0.001	0.105
Lysine														0.137*	0.135*
Trytophene															-0.011
Grain yield / plant (g)															1.000

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

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