RESEARCH ARTICLE

Estimation of Correlation and Path Association in Hexaploid Wheat (*Triticum aestivum* L.) with the Feasibility of Developing F1 Hybrid in Half Diallel Mating Design

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Abstract

The present study was carried out at Mata Gujri College, Fatehgarh Sahib's Experimental Farm, Department of Agriculture, Punjab during 2019-20, and 2020-21. The experimental material consisted of six parental varieties (HD 1981, PBW 343, CPAN 3004, RAJ 2184, PBW 154, and PBW 65) collected from the Indian Institute of Wheat and Barley Research (IIWBR) New Delhi, India and their 15 F_1s obtained from half diallel mating design were grown in Randomized Block Design. The association studies among different characters showed that grain yield per plant had a significant positive correlation with no. of grain per plant, that can be successfully used for the genetic improvement of seed yield in bread wheat.

Keywords: Correlation, Path association, Genotype, Genetics, Hexaploid.

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Introduction

Bread wheat belongs to family Poaceae with chromosome no. 2n=42. The wheat crop has played important role in stabilizing food grains production in the country over the past few years. It is essential that production and productivity of wheat must be increased. Because India's population goes increase day by day and it has been becomes challenge for agriculture scientists; how to fulfil projected demand of the world population for food grains. Wheat grains consists a protein named 'gluten', which is helpful to chapatti making or affect the baking quality of bread. Due to the presence of gluten content in wheat it also helps to making pasta, noodles and other food products. It is also a source of vitamins of B-complex and minerals. Dietary fibres present in wheat germ and bran can be a used as source of prevention of digestive disorders and their treatment (Simmonds, 1989).

The milled grain of durum wheat consist antioxidant activity and phytochemical content. In wheat, predominant carotenoid named Lutien is present (Adomet *et al.,* 2003 & Abdel-Aal *et al.,* 2007). Both Lutien and zeaxanthin together useful for the skin and eyes in humans (Abdel-Aal *et al.,* 2007).

Worldwide cultivated area under wheat crop is 221.55 million hectares with production of 750.44 million tonnes and productivity 3.39 metric tonnes per hectare (Anonymous, 2018). China, India, USA, Russia, France, Canada, Germany, Turkey, Australia and Ukrain are main wheat growing countries. During (2017-18) wheat crop is grown on area 31.86 million hectare with the average production of 95 million tonnes and yield of 3.0 metric tonnes per hectare in India (Anonymous, 2018). The statistical measure as correlation coefficient analysis that measures the mutual relationship between various plant traits and determines the component traits for genetic improvement in yield (Miller *et al.,* 1958).

Correlations also gave information about relationship among yield and its yield related components. This type of information based on trait association, is used in directional selection to predict correlated response and construction of selection indices. It can also be useful in- identification of those traits that have not valuable by themselves, but used as indicators (Johnson *et al.,* 1955).

Yield of several traits which are correlated among them considered as dependent trait effect. From dependent trait effect path coefficient analysis was developed by Wright, (1921) & Dewey and Lu, (1959). Path coefficient measures the direct and indirect effect of independent components on yield character.

Materials And Methods

Estimation of Association Coefficients

At genotypic (g), phenotypic (p) and environmental levels the association between various traits measures by Correlation coefficients analysis as per formula suggested (Miller *et al.,* 1958).

- Correlation coefficient at genotypic level between x and y trait

$$rxy (g) = Covxy (g) \sqrt{} (V x (g) x V y (g))$$

- Correlation coefficient at phenotypic level between x and y trait

$$rxy (p) = Covxy (p) \sqrt{} (V x (p) x V y (p))$$

Table 1: Correlation at Genotypic level

Chrs	Days to booting	Days to heading	Days to anthesis	Days to maturity	No productive tillers	Plant height (cm)	Peduncle length (cm)	Spike length (cm)	No.of spikelet/ spike	No.of grain/ spike	No. of grain per plant	Test weight (g)	Biological yield/plant (g)	Harvest index	Grain yield/ plant (g)
Days to booting	1.000	0.462**	0.117	0.586**	0.228	-0.068	-0.322**	0.201	-0.329**	-0.258*	0.109	-0.148	0.282*	-0.480**	-0.066
Days to heading			0.430**	0.362**	-0.134	-0.401**	-0.115	-0.091	-0.442**	-0.194	-0.108	-0.045	-0.042	-0.268*	-0.190
Days to anthesis				0.489**	-0.088	-0.130	-0.394**	-0.272*	-0.479**	-0.156	-0.102	-0.302*	-0.208	-0.113	-0.221
Days to maturity					0.044	-0.217	-0.279*	-0.010	-0.314*	-0.497**	-0.166	-0.142	0.136	-0.534**	-0.223
No.of productive tillers						0.147	-0.100	0.353**	-0.181	-0.037	0.832**	0.115	0.663**	0.220	0.658**
Plant height (cm)							-0.058	0.032	0.542**	-0.264*	-0.067	0.002	0.105	-0.386**	-0.200
Peduncle length (cm)								-0.111	0.283*	0.330**	0.017	0.366**	-0.020	0.223	0.150
Spike length (cm)									0.137	0.296*	0.462**	0.425**	0.571**	0.022	0.465**
No.of spikelet/spike										0.147	-0.087	0.318**	0.227	-0.158	0.058
No.of grain/spike											0.478**	0.064	0.236	0.520**	0.536**
No. of grain per plant												0.080	0.726**	0.439**	0.862**
Test weight (g)													0.358**	0.235	0.444**
Biological yield/plant (g)														-0.051	0.756**
Harvest index															0.610**
Grain yield/plant (g)															1.000

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

rxy (g) = Correlation coefficient at genotypic level between x and y
rxy (p) = Correlation coefficient at phenotypic level between x and y
Covxy (g) = Covariance at genotypic level between x and y
Covxy (p) = Covariance at phenotypic level between x and y
V x (g) = Variance of x at genotypic level
V x (p) = Variance of x at phenotypic level
V y (g) = Variance of y at genotypic level
V y (p) = Variance of y at phenotypic level

Estimation of Path Association

Wright, (1921) developed Path analysis and Dewey and Lu, (1959) used it first for plant selection. It measures the effect of independent variables on dependent variable as direct and indirect contributions.

Value of Direct and Indirect Effects Rate/Scale

0.00 to 0.09 negligible
0.10 to 0.19 Low
0.20 to 0.29 Moderate
0.30 to 0.99 High
> 1.00 Very high

Results And Discussion

Correlation Coefficient

The results are shown in Table 1 and 2 at genotypic and phenotypic level respectively. Yield is contribution of many dependent and independent traits of plant. And measurement of genetic parameters of yield only on single yield trait is not sufficient. So, knowledge about the correlation coefficient is important to measures association between different traits contributes towards yield. Correlation could be genotypic, phenotypic and environmental. Genotypic correlation describes a genetic relationship between different traits may be due to pleiotropy, linkage or gene frequency disequilibrium. Phenotypic correlation measure relationship genetically as well as environmentally. Environment correlation is due to non-genetic factors means environment effect (Khan *et al.,* 2005).

Correlation coefficient is useful to breeders because it determine the association between different traits. By using this data, one can know about how to do selection of different traits that are not amenable to direct selection and so indirect selection becomes inevitable and also useful for directional selection that helps to predict genetic advance (Sokoto *et al.,* 2012).

In the present study, both genotypic and phenotypic association was almost similar for most of the characters. Association studies observed that grain yield per plant was positively and significantly correlated with no. of grains/plant followed by biological yield/plant, harvest index, tillers/plant, test weight, grains/spike and spike length. Similar results of association ship were observed (Dabi *et al.,* 2016; Preeti *et al.,* 2018; Kotal *et al.,* 2010). Other traits, however shows an insignificant results with grain yield. The phenotypic correlation coefficient values are lower than value of genotypic

Table 2: Correlation at Phenotypic level

Chrs	*Days to booting*	*Days to heading*	*Days to anthesis*	*Days to maturity*	*No productive tillers*	*Plant height (cm)*	*Peduncle length (cm)*	*Spike length (cm)*	*No.of spikelet/ spike*	*No.of grain/ spike*	*No. of grain per plant*	*Test weight (g)*	*Biological yield/plant (g)*	*Harvest index*	*Grain yield/ plant (g)*
Days to booting	1.000	0.388**	0.084	0.506**	0.193	0.006	-0.140	0.129	-0.082	-0.222	0.107	-0.125	0.193	-0.300*	-0.042
Days to heading			0.376**	0.300*	-0.129	-0.349**	-0.145	-0.079	-0.351**	-0.159	-0.114	-0.059	-0.055	-0.235	-0.193
Days to anthesis				0.309*	-0.035	-0.111	-0.244*	-0.183	-0.353**	-0.169	-0.073	-0.227	-0.142	-0.139	-0.192
Days to maturity					-0.006	-0.143	-0.229	0.004	-0.205	-0.339**	-0.161	-0.093	0.129	-0.451**	-0.198
No.of productive tillers						0.122	-0.006	0.265*	-0.121	-0.161	0.794**	0.102	0.587**	0.235	0.617**
Plant height (cm)							-0.071	0.062	0.455**	-0.237	-0.067	-0.024	0.092	-0.336**	-0.189
Peduncle length (cm)								0.010	0.289*	0.191	0.047	0.210	-0.019	0.183	0.120
Spike length (cm)									0.066	0.226	0.378**	0.251*	0.366**	0.086	0.340**
No.of spikelet/spike										0.080	-0.064	0.209	0.185	-0.094	0.061
No.of grain/spike											0.396**	0.049	0.193	0.391**	0.426**
No. of grain per plant												0.074	0.687**	0.425**	0.832**
Test weight (g)													0.330**	0.299*	0.479**
Biological yield/plant (g)														-0.088	0.719**
Harvest index															0.623**
Grain yield/plant (g)															1.000

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

Table 3: Genotypic path with grain yield per plant

Chrs	*Days to booting*	*Days to heading*	*Days to anthesis*	*Days to maturity*	*No productive tillers*	*Plant height (cm)*	*Peduncle length (cm)*	*Spike length (cm)*	*No.of spikelet/ spike*	*No.of grain/ spike*	*No. of grain per plant*	*Test weight (g)*	*Biological yield/plant (g)*	*Harvest index*	*R with Grain yield/ plant (g)*
Days to booting	0.369	-0.162	0.068	-0.414	-0.045	0.032	-0.120	0.050	-0.049	0.158	-0.014	0.038	0.349	-0.326	-0.066
Days to heading	0.171	-0.351	0.253	-0.256	0.027	0.187	-0.043	-0.023	-0.065	0.118	0.014	0.012	-0.051	-0.182	-0.190
Days to anthesis	0.043	-0.151	0.587	-0.345	0.018	0.061	-0.147	-0.068	-0.071	0.095	0.013	0.078	-0.257	-0.077	-0.221
Days to maturity	0.216	-0.127	0.287	-0.707	-0.009	0.101	-0.104	-0.002	-0.046	0.304	0.021	0.037	0.168	-0.363	-0.223
No.of productive tillers	0.084	0.047	-0.052	-0.031	-0.199	-0.069	-0.037	0.088	-0.027	0.022	-0.108	-0.030	0.819	0.150	0.658**
Plant height (cm)	-0.025	0.141	-0.077	0.153	-0.029	-0.467	-0.022	0.008	0.080	0.161	0.009	-0.001	0.130	-0.262	-0.200
Peduncle length (cm)	-0.119	0.040	-0.231	0.197	0.020	0.027	0.374	-0.028	0.042	-0.202	-0.002	-0.095	-0.025	0.152	0.150
Spike length (cm)	0.074	0.032	-0.160	0.007	-0.070	-0.015	-0.042	0.249	0.020	-0.181	-0.060	-0.110	0.705	0.015	0.465**
No.of spikelet/spike	-0.121	0.155	-0.281	0.222	0.036	-0.253	0.106	0.034	0.148	-0.090	0.011	-0.082	0.281	-0.107	0.058
No.of grain/spike	-0.095	0.068	-0.092	0.351	0.007	0.123	0.123	0.074	0.022	-0.611	-0.062	-0.017	0.292	0.353	0.536**
No. of grain per plant	0.040	0.038	-0.060	0.117	-0.165	0.031	0.006	0.115	-0.013	-0.292	-0.130	-0.021	0.896	0.298	0.862**
Test weight (g)	-0.055	0.016	-0.178	0.100	-0.023	-0.001	0.137	0.106	0.047	-0.039	-0.010	-0.259	0.442	0.160	0.444**
Biological yield/plant (g)	0.104	0.015	-0.122	-0.096	-0.132	-0.049	-0.008	0.142	0.034	-0.145	-0.094	-0.093	1.235	-0.035	0.756**
Harvest index	-0.177	0.094	-0.067	0.378	-0.044	0.180	0.083	0.005	-0.023	-0.318	-0.057	-0.061	-0.063	0.679	0.610**

Resi = 0.0068

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

Table 4: Phenotypic path with grain yield per plant

Chrs	Days to booting	Days to heading	Days to anthesis	Days to maturity	No productive tillers	Plant height (cm)	Peduncle length (cm)	Spike length (cm)	No.of spikelet/ spike	No.of grain/ spike	No. of grain per plant	Test weight (g)	Biological yield/ plant (g)	Harvest index	R with Grain yield/plant (g)
Days to booting	0.025	-0.012	0.001	-0.002	-0.009	0.000	-0.001	-0.002	0.001	0.003	0.012	-0.008	0.137	-0.186	-0.042
Days to heading	0.010	-0.032	0.006	-0.001	0.006	0.013	-0.001	0.001	0.004	0.002	-0.013	-0.004	-0.040	-0.146	-0.193
Days to anthesis	0.002	-0.012	0.016	-0.001	0.002	0.004	-0.002	0.003	0.004	0.002	-0.008	-0.015	-0.101	-0.086	-0.192
Days to maturity	0.012	-0.009	0.005	-0.004	0.000	0.005	-0.001	0.000	0.002	0.005	-0.018	-0.006	0.092	-0.280	-0.198
No.of productive tillers	0.005	0.004	-0.001	0.000	-0.047	-0.005	0.000	-0.005	0.001	0.002	0.091	0.007	0.418	0.146	0.617**
Plant height (cm)	0.000	0.011	-0.002	0.001	-0.006	-0.038	0.000	-0.001	-0.005	0.003	-0.008	-0.002	0.066	-0.209	-0.189
Peduncle length (cm)	-0.003	0.005	-0.004	0.001	0.000	0.003	0.006	0.000	-0.003	-0.003	0.005	0.013	-0.014	0.113	0.120
Spike length (cm)	0.003	0.002	-0.003	0.000	-0.012	-0.002	0.000	-0.018	-0.001	-0.003	0.043	0.016	0.261	0.053	0.340**
No.of spikelet/spike	-0.002	0.011	-0.006	0.001	0.006	-0.017	0.002	-0.001	-0.011	-0.001	-0.007	0.013	0.132	-0.058	0.061
No.of grain/spike	-0.005	0.005	-0.003	0.001	0.008	0.009	0.001	-0.004	-0.001	-0.014	0.045	0.003	0.138	0.243	0.426**
No. of grain per plant	0.003	0.004	-0.001	0.001	-0.037	0.003	0.000	-0.007	0.001	-0.006	0.115	0.005	0.490	0.264	0.832**
Test weight (g)	-0.003	0.002	-0.004	0.000	-0.005	0.001	0.001	-0.004	-0.002	-0.001	0.008	0.064	0.235	0.186	0.479**
Biological yield/plant (g)	0.005	0.002	-0.002	-0.001	-0.028	-0.004	0.000	-0.007	-0.002	-0.003	0.079	0.021	0.712	-0.054	0.719**
Harvest index	-0.007	0.007	-0.002	0.002	-0.011	0.013	0.001	-0.002	0.001	-0.006	0.049	0.019	-0.062	0.621	0.623**

Resi = 0.00574 *, ** significant at 5% and 1% level, respectively

correlation coefficient showed strong association between these traits genetically but phenotypically less due to environment effect. Khasn and Dar, (2009) estimated same results for most of the traits.

Number of grains per plant positively correlate with grain yield per plant this result showed that improvement in no. of grain per plant positively improves the grain yield per plant.

Path Analysis

The results are shown in Table 3 and 4 at genotypic and phenotypic level respectively. From correlation only relationship measured between two variables. But, from path analysis both cause and relationship measured. In this, correlation coefficients were portioned into direct and indirect effects to know about cause of relationship of each factor on grain yield.

Dewey and Lu, (1959) gave the method of analysis and have been used to estimate the direction and magnitude of direct and indirect effect of various yield and its contributing traits. If the correlation is due to direct effect of a character between yield and its contributing character, it reveals true relationship and direct selection for this trait will be rewarding for yield improvement. Sometimes, if due to indirect effect of the character through another component trait, indirect selection will be effective in improvement of yield. Correlation with path analysis association provide information about determinants of yield and their phenotypic and genotypic correlation.

Path analysis, revealed significant and positive direct effect of grain/plant, tillers/plant, biological yield per plant, spike length, test weight, harvest index (HI) and grain per spike with grain yield. Days to maturity, showed negative direct effect on yield. On booting and maturity with grain yield similar results were reported (Suleiman *et al.,* 2014). Similarly, Aycicek and Yildirim, (2006) reported high positive direct effect of grain yield/plant, which are conformity with present studies. Days to booting, days to heading, days to anthesis, maturity days and plant height not show any relationship with grain yield/plant exhibited considerable negative contribution directly.

On the basis of above findings, three traits viz., harvest index, biological yield per plant and Spike length were found most important components for further yield improvement in bread wheat.

Conclusion

Above results showed that number of grain per plant positively correlate with grain yield per plant at both phenotypic and genotypic level. Path coefficient analysis observed magnitude of positive direct effect of number of grain per plant on grain yield per plant at both phenotypic and genotypic level. From these results it was concluded that yield traits as spike length, number of spikelets per spike positively correlate with yield traits and directly effect grain yield. So, these are most useful traits for further improvement of yield traits of wheat.

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