Estimate of Heritability Genetic Advances Genotypic and Phenotypic Correlation in Bread Wheat (*Triticum aestivum* L.)

Abstract

The current study was conducted on several genotypes during crop season of Rabi 2021-2022 and 2022-2023 with the goal of to work out heritability in general and genetic advance in percentage of mean and estimate correlation coefficient among the growth and yield traits. The field experiments included 60 germplasms of bread wheat. Experimental trials were conducted in 12 environments (E1 to E12).The field experiments were laid out in Augmented Block Design (ABD).The observations on 26 physio-morphological and yield related traits were recorded in both non-stressed and heat-stressed environment.High genotypic and phenotypic coefficients of variation were observed for plant waxiness, followed by grain yield per plant and leaf rolling. Heritability coupled with genetic advance were identified in yield per plot (g), grain yield / plant (gm), plant waxiness (0-10 scale).Grain yield per plant exhibited significant positive correlation with grain length (0.712), harvest index (0.629), leaf rolling (0.4638). It exhibited significant negative correlation with plant height (-0.461) and canopy temperature depression (-0.233).

Keywords:*Bread wheat,~~(Triticum aestivum L.) correlation~~ genotypiccorrelation; phenotypiccorrelation; path coefficient; quantitative trait.*

INTRODUCTION

Wheat (*Triticumaestivum* L., 2n=42) is the most important cereal in the world.Wheat belongs to the family Poaceae (Gramineae) and tribe Triticeae containing more than 15 genera and 300 species including wheat and barley.*T. aestivum* isa segmental allohexaploid (2n = 6x = 42, AABBDD) originated in the Fertile Crescent area of South-Western Asia, its geographical centre of origin and spread globally for cultivation and consumption.It has a strong nutritional profile, with 12.1% protein, 1.8%~~percent~~ lipids, 1.8%~~percent~~ ash, 2.0%~~percent~~ reducing sugars, 6.7%~~percent~~ pentosans, 59.2% starch, and 70% total carbohydrates, Calcium (37 mg/100g), iron (4.1 mg/100g), thiamine (0.45 mg/100g), riboflavin (0.13 mg/100g), and nicotinic acid (5.4 mg/100mg) are all good sources of minerals and vitamins (Ref). Grain yield is a complex quantitative trait, considerably affected by environment (Khan and Naqvi 2012). It is important to determinethe contribution of the traits which has the greatest influence on grain yield (Desheva 2016). The heat-stress reduces the grain yield and yield-related traits by

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enhancingleafsenescence,reductioninphotosynthesis,deactivationofphotosyntheticenzymes, assimilate translocation and duration, reduction in grain number and sizeby affecting grain setting and growth rate of grains (Akter and Islam, 2017). Hightemperature reduces yield by 3-4% for every 1^0C rise in temperature leading toreduced globalwheatproductivityby5%.Morphological characterization using phenotypic traits associated with heat-stress tolerance is a right approach for underpinning the physiological mechanisminvolved in wheat crop adaptation to global warming (Bita and Gerats, 2013; Hyles*et al.*,2020).

Correlation in grouping with path analysis will provide a better understanding of the cause and-effect relationship between distinct pairs of characters. Correlation analyses are important for determining the degree and direction of the link between yield and its component qualities. Meanwhile, route coefficient analysis assesses the direct and indirect contribution of independent factors to dependent variables, which may help breeders determine yield components and identify the source of link between two variables.

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MATERIAL AND METHOD

The current investigation entitled was conducted at three different locations; namely:

~~1.~~ Crop research farm, Nawabganj,

~~2.~~ Crop research farm, Araul and

~~3.~~ Crop research farm, Daleep Nagar, India~~.~~

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during crop season of Rabi 2021-2022 and 2022 2023 under normal (non-stressed) and late sown (heat-stressed) conditions.The field experiments were planted comprising 60 germplasm of bread wheat (Table 1).Therefore, our experimental trials were conducted in 12 environments (E1 to E12), which included six non-stressed (NS) and six heat-stressed (HS) environments.The field experiments were laid out in Augmented Block Design (ABD). Each experimental plot consisted of three rows of 2m length with 20 cm spacing between rows covering an area of 2 m x 0.20m (1.2 m^2) under irrigated condition.The observations on 26 physio-morphological and yield related traits were recorded*viz.*, ~~D~~days to 50% flowering, ~~P~~plant height (cm), ~~S~~spike bearing tillers per plant, ~~F~~flag leaf length (cm), ~~F~~flag leaf width (cm), ~~C~~chlorophyll content, ~~C~~canopy temperature depression (0C), ~~P~~plant waxiness (0-10), ~~L~~leaf rolling (0-10 scale), ~~G~~grain filling period (days), ~~S~~spike length (cm), ~~N~~number of spikelets per spike, p~~P~~lant biomass (g), ~~N~~number of grains per spike, ~~N~~number of grains per plant, ~~G~~grain length(mm), ~~G~~grain yield ~~/(plant~~(g/plant), ~~H~~harvest index (%), 1000-grain weight(g), ~~P~~protein content (%).The analysis of variance for 26 quantitative traits among 60 genotypes showed

significant variation for all the traits studied. This indicates ~~the presence of~~a high degree of variability among the genotypes~~,and~~ suggestingample scope ~~of~~ forimprovement by selection.

Table-1 Details of bread wheat accessions used in the study.

Sr. No.	Genotypes	Sr. No.	Genotypes
1.	K-1711	31.	K-2105
2.	K-1903	32.	K-2109
3.	K-1805	33.	K-0307
4.	K-1907	34.	K-0607
5.	K-1910	35.	K-1803
6.	K-2003	36.	K-1317
7.	K-0306	37.	PBW-852
8.	K-0402	38.	DBW-173
9.	K-2107	39.	HD-3388
10.	K-2121	40.	HD-2359
11.	K-8962	41.	K-9644
12.	K-9351	42.	K-2101
13.	K-9465	43.	KRL-213
14.	K-8027	44.	KRL-19
15.	K-2103	45.	PBW-826
16.	K-1006	46.	DBW-187
17.	K-1616	47.	HD-3392
18.	K-1905	48.	HD-2967
19.	K-1809	49.	DBW-107
20.	K-1908	50	DBW-222
21.	K-2001	51.	PBW-833
22.	K-2007	52.	HD-3399
23.	K-9107	53.	PBW-835
24.	K-9162	54.	KRL-210
25.	K-9533	55.	KRL-1-4
26.	K-2108	56.	K-2010
27.	K-9423	57.	KRL-283
28.	K-8434	58.	DBW-350
29.	K-7903	59.	HD-3086
30.	K-2104	60.	WH-1142

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Comment [MSI4]: Statistical analysis??

RESULT AND DISCUSSION

Estimation of selection parameters

The presence of variability in yield and yield attributing characters provides scope for the yield improvement through selection process. High genotypic and phenotypic coefficients of variation were observed for plant waxiness, followed by grain yield per plant and leaf rolling. Moderate genotypic and phenotypic coefficients of variation were noted for spike-bearing tillers per plant, followed by canopy temperature depression, 1000-grain weight, flag leaf

length, number of grains per spike, chlorophyll content, peduncle length, days to 50% heading, flag leaf width, and spike length. Heritability coupled with genetic advance will be instrumental in predicting genetic gain in the breeding program. Johnson *et al.* (1955a) described that selection based on heritability alone will be inappropriate, thus stressed the importance of genetic gain. In the present investigation, heritability coupled with genetic advance were identified in yield per plot (g/plot), grain yield /plant (g/mplant), plant waxiness (0-10 scale), number of grains per plant, 1000-grain weight (gm), harvest index (%), flag leaf area (cm²), grain weight per spike, canopy temperature depression (°C), flag leaf length (cm), days of 50% heading and spike bearing tillers per plant. A similar pattern of results with high heritability and genetic advance as per cent of mean were observed by Gowda *et al.* (2011), Sharma *et al.* (2018) and Al-Ashkar *et al.* (2023).

Comment [MSI5]: Rewrite

Phenotypic and Genotypic Coefficient of Variation

All the traits such as chlorophyll content, canopy temperature depression (°C), days of 50% heading, flag leaf length (cm), harvest index (%), flag leaf width (cm), leaf rolling (0-10 scale), number of grain per plant, grain filling period (days), grain length (mm), grain yield per plant (g/plant), number of grains per spike, number of spikelets per spike, plant biomass (gm), protein content (%), plant height (cm), plant waxiness (0-10 scale), spike bearing tillers per plant, spike length (cm) and 1000-grain weight (g) exhibited lowest range of genotypic coefficient of variation.

The majority of the traits in the dataset such as chlorophyll content, canopy temperature depression (°C), days of 50% heading, flag leaf length (cm), harvest index (%), flag leaf width (cm), number of grain per plant, grain filling period (days), grain length (mm), grain yield per plant (g), number of grains per spike, number of spikelets per spike, plant biomass (gm), protein content (%), plant height (cm), spike bearing tillers per plant, spike length (cm) and 1000-grain weight (g) exhibited lowest range of genotypic coefficient of variation. While, plant waxiness (0-10 scale) and leaf rolling (0-10 scale) exhibited moderate range of genotypic coefficient of variation.

The highest heritability was observed in protein content (%). The moderate range of heritability was observed in plant waxiness, grain yield per plant, flag leaf length,1000-grain weight, canopy temperature depression, plant height, number of grains per spike, chlorophyll content, harvest index, days of 50% heading, spike bearing tillers per plant, flag leaf width and plant biomass. The lowest range of heritability was observed in number of grains per plant, leaf rolling, spike length, grain filling period, number of spikelets per spike, and grain

length.The moderate genetic advance as percentage of mean was observed in plant waxiness (0-10 scale). While, the lowest genetic advance as percentage of mean was observed in chlorophyll content, canopy temperature depression , days of 50% heading, flag leaf length, harvest index (%), flag leaf width, leaf rolling (0-10 scale), number of grain per plant, grain filling period (days), grain length, grain yield per plant, number of grains per spike, number of spikelets per spike, plant biomass, protein content, plant height, spike bearing tillers per plant, spike length and 1000-grain weight.

CORRELATION ANALYSIS

Grain yield per plant exhibited a significant positive correlation with grain length, harvest index, leaf rolling, grain filling period, protein content and days of 50% heading. Conversely, it showed a significant negative correlation with plant height and canopy temperature depression. It was found that these results coincided with the findings of Laxman *et al.* (2014), Abdul Hamid *et al.* (2017) and Akbarzai*et al.* (2022) for grain weight per spike; Ahmad *et al.* (2018) for spike length; Pooja *et al.* (2018) for harvest index.

GENOTYPIC CORRELATION

The genetic correlation analysis for all the 26 characters is presented in Table2.

Days to 50% heading had exhibitedhighly significant and positively correlation with spike bearing tiller per plant (0.487). While showing a significant and negative correlation with chlorophyll content (-0.333).Grain filling period (GFP) exhibited significant and positive correlations with panicle mass (0.761), grain yield per plant (0.402), leaf rolling (0.357), canopy temperature depression (0.345), harvest index (0.296), and spike bearing tillers per plant (0.308). Conversely, GFP showed significant and negative correlations with chlorophyll content (-0.319).Flag leaf length exhibited significant positive correlations with number of spikelets per spike (0.397), grain length (0.370), plant count (0.340), and chlorophyll content (0.338). Conversely, FLL showed significant negative correlations with panicle mass (-0.570) and plant height (-0.334).Flag leaf width exhibited significant positive correlations with number of spikelets per spike (0.496) and harvest index (0.355). It also showed significant negative correlations with plant biomass (-0.409), Plant waxiness (0-10 scale) (-0.333), and leaf rolling (-0.267). Plant height (PH) demonstrated significant positive correlations with peduncle length (PL) (0.8515 **) and 1000-grain weight (0.255), but significant negative correlations with grain yield per plant (-0.461), leaf rolling (-0.358), flag leaf length (-0.334), number of grains per spike (-0.275), and harvest index (-0.260).Spike bearing tillers per plant showed a strong positive correlation

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with days to 50% heading (0.487), grain length (0.483), and canopy temperature depression (0.480). It had a significant negative correlation with grain filling period (-0.319) and plant mass (-0.273).Chlorophyll content (CC) exhibited significant negative correlations with days to 50% heading (-0.333), as well as 1000-grain weight (-0.308). It showed significant positive correlations with the number of grains per panicle (0.408), flag leaf length (0.338) and grain filling period (0.308). Canopy temperature depression had a strong negative correlation with number of grains per plant (-0.510), number of grains per spike (-0.388), and grain yield per plant (-0.233), while showing a positive correlation with spike-bearing tillers per plant (0.480), number of spikelets per spike (0.397), grain filling period (0.345), and grain length (0.312). Protein content (-0.293) was negatively correlated.Plant waxiness exhibited a significant positive correlation only with leaf rolling (0.301). It showed significant negative correlations with number of spikelets per spike (-0.351), spike length (-0.320) and flag leaf width (-0.333).Leaf rolling exhibited significant positive correlations with grain yield per plant (0.463), grain length (0.435), harvest index (0.373), grain filling period (0.357), plant waxiness (0.301). It exhibited significant negative correlations with plant height (-0.358), number of spikelets per spike (-0.327), 1000 grain weight (-0.273), flag leaf width (-0.267).Spike length exhibited significant positive correlations with number of spikelets per spike (0.723), plant biomass (0.408), grain length (0.540). It exhibited significant negative correlations with number of grains per plant (-0.624), 1000-grain weight (-0.519), harvest index (-0.367) and plant waxiness (-0.320).Number of spikelets per spike exhibited significant positive correlation with flag leaf width (0.496), 1000-grain weight (0.562), flag leaf length (0.397), canopy temperature depression (0.397), spike length (0.723). It also exhibited significant negative correlation with grain length (-0.788), harvest index (-0.545), plant waxiness (-0.351), leaf rolling (-0.327), grain yield per plant (-0.302).Plant biomass exhibited significant positive correlation with spike length (0.408), number of spikelets per spike (0.562), 1000-grain weight (0.347). It exhibited significant negative correlations with harvest index (-0.773), flag leaf width (-0.409), number of grains per spike (-0.313).Number of grains per spike exhibited significant positive correlation with harvest index (0.276). It also exhibited significant negative correlation with grain length (-0.091), canopy temperature depression (-0.388), plant biomass (-0.313).Number of grains per plant exhibited significant positive correlation with chlorophyll content (0.408), harvest index (0.301), protein content (0.270). It exhibited significant negative correlation with grain length (-0.673), spike length (-0.624), canopy temperature depression (-

0.510).Grain length exhibited significant positive correlation with grain yield per plant (0.712), spike length (0.540), spike bearing tillers per plant (0.483), protein content (0.473), leaf rolling (0.435), flag leaf length (0.370), harvest index (0.364), canopy temperature depression (0.312). Additionally, It also exhibited significant negative correlation with number of spikelets per spike (-0.788), number of grains per plant (-0.673), 1000-grain weight (-0.337).1000-grain weight exhibited significant positive correlation with plant biomass (0.347), plant height (0.255). It exhibited significant negative correlation with spike length (-0.519), harvest index (-0.352), grain length (-0.337).Grain yield per plant exhibited significant positive correlation with grain length (0.712), harvest index (0.629), leaf rolling (0.463), days of 50% heading (0.274), grain filling period (0.402), protein content (0.3767). It exhibited significant negative correlation with plant height (-0.461). Harvest index exhibited significant positive correlation with grain yield per plant (0.629), leaf rolling (0.373), grain length (0.364), flag leaf width (0.355), number of grain per plant (0.301), protein content (0.296). It also exhibited significant negative correlation with plant biomass (-0.773), days of 50% heading (-0.545), spike length (-0.367), 1000 grain weight (-0.352). Protein content exhibited significant positive correlation with grain length (0.473), grain yield per plant (0.376), flag leaf length (0.340), number of grain per plant (0.270). It exhibited significant negative correlation with canopy temperature depression (-0.293).

PHENOTYPIC CORRELATION ANALYSIS

The genetic correlation analysis for all the 26 characters is presented in Table 3a, Table 3 b and Table 3c.

Days to 50% heading showed significant positive correlations with spike bearing tillers per plant (0.180).Flag leaf lengthshows a significant positive association with protein content (0.222), and canopy temperature depression (0.172). It also has a significant negative association with plant height (-0.190) and chlorophyll content (-0.171).Spike bearing tillers per plant shows a significant positive association with canopy temperature depression (0.210) and days of 50% heading (0.180).Chlorophyll content shows a significant positive association with flag leaf length (0.171) and the number of grains per plant (0.158).Canopy temperature depression shows a significant positive association with spike bearing tillers per plant (0.210), the number of spikelets per spike (0.208), and flag leaf length (0.172). It also has a significant negative association with protein content (-0.171).Plant waxiness shows a significant negative association with flag leaf width (-0.160).Spike length shows a significant positive

association with the number of spikelets per spike (0.201).The number of spikelets per spike shows a significant positive association with plant biomass (0.310), canopy temperature depression (0.208), and spike length (0.201). It also has a significant negative association with the harvest index (-0.287) and plant height (-0.211).Plant biomass shows a significant positive association with the number of spikelets per spike (0.310). It also has a significant negative association with the harvest index (-0.837).The number of grains per plant shows a significant negative association with the grain length (-0.174). It also has a significant positive association with chlorophyll content (0.158).Grain length shows has a significant negative association with the number of grains per plant (-0.174).Grain yield per plant shows a significant positive association with the harvest index (0.456) and protein content (0.235). It also has a significant negative association with plant height (-0.205).The harvest index shows a significant positive association with grain yield per plant (0.456). It also has a significant negative association with plant biomass (-0.837) and the number of spikelets per spike (-0.287).Protein content shows a significant positive association with grain yield per plant (0.235) and flag leaf length (0.222).Flag l~~L~~eaf ~~W~~w idth show~~s~~ed a significant positive association with flag leaf area (0.615). It also has a significant negative association with plant waxiness (-0.160).Plant ~~H~~height shows a significant negative association with the number of spikelets per spike (-0.211), grain yield per plant (-0.205), flag leaf length (-0.190).

Table 3a: Parameters of genetic variability for yield and yield related traits

	Chlorophyll content	Canopy temperature depression (°C)	Days of 50% ~~H~~heading	Flag leaf length (cm)	Harvest index (%)	Flag leaf width (cm)	Leaf rolling (0-10 scale)	Number of grains per plant	Grain filling period (days)	Grain length (mm)
Maximum	33.658	8.742	79.083	26.883	65.325	2.175	6.883	536.567	30.917	7.067
Minimum	26.100	6.267	74.750	20.308	48.047	1.733	3.417	396.450	28.333	6.358
Grand Mean	29.707	7.699	76.864	23.143	55.359	1.969	5.455	458.555	29.569	6.735
Standard Error of Mean (SEm)	0.683	0.223	0.425	0.477	1.619	0.039	0.329	13.449	0.282	0.070
Critical Difference (CD) 5%	1.914	0.624	1.190	1.336	4.535	0.108	0.921	37.664	0.790	0.1949 NS
Critical Difference (CD) 1%	2.530	0.825	1.573	1.766	5.996	0.143	1.217	49.796	1.045	0.2577 NS
Environmental Variance	1.401	0.149	0.541	0.682	7.868	0.005	0.324	542.617	0.239	0.015
Genotypic Variance	0.779	0.109	0.281	0.658	4.162	0.002	0.122	219.421	0.054	0.001
Phenotypic Variance	2.180	0.258	0.822	1.340	12.030	0.007	0.446	762.037	0.293	0.016
Environmental Coefficient of Variance	3.985	5.011	0.957	3.569	5.067	3.393	10.439	5.080	1.653	1.790
Genotypic Coefficient of Variance	2.971	4.294	0.689	3.505	3.685	2.382	6.390	3.230	0.788	0.492
Phenotypic Coefficient of Variance	4.970	6.599	1.180	5.002	6.265	4.158	12.240	6.020	1.831	1.855
Heritability (Broad Sense)	0.357	0.424	0.342	0.491	0.346	0.328	0.273	0.288	0.185	0.071
Genetic Advance	1.087	0.443	0.638	1.171	2.472	0.055	0.375	16.374	0.207	0.018
Genetic Advance as percentage of mean	3.659	5.757	0.830	5.058	4.466	2.814	6.872	3.571	0.699	0.269

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Table3b : Parameters of genetic variability for yield and yield related traits

	Grain yield per plant (g)	Number of grains per spike	Number of spikelets per spike	Plant biomass (gm)	Protein content (%)	Plant height (cm)	Plant waxiness (0-10scale)	Spike bearing tillers per plant	Spike length(cm)	1000-grain weight(g)
Maximum	30.683	52.200	22.383	59.500	14.723	109.408	7.567	14.117	12.133	42.525
Minimum	24.942	39.417	17.383	44.468	10.942	93.108	4.017	10.350	9.592	35.017
Grand Mean	27.346	44.792	20.116	50.967	12.157	100.677	5.644	12.302	10.654	38.671
Standard Error of Mean (SEm)	0.373	1.254	0.474	1.439	0.148	1.455	0.260	0.327	0.214	0.640
Critical Difference (CD) 5%	1.044	3.512	1.327	4.030	0.416	4.074	0.727	0.916	0.600	1.792
Critical Difference (CD) 1%	1.381	4.643	1.7539 NS	5.328	0.549	5.386	0.961	1.211	0.793	2.369
Environmental Variance	0.417	4.718	0.673	6.211	0.066	6.348	0.202	0.321	0.138	1.228
Genotypic Variance	0.410	2.665	0.112	2.670	0.268	4.493	0.252	0.165	0.050	1.031
Phenotypic Variance	0.827	7.383	0.785	8.881	0.334	10.841	0.454	0.486	0.188	2.259
Environmental Coefficient of Variance	2.362	4.849	4.079	4.890	2.114	2.503	7.967	4.604	3.483	2.866
Genotypic Coefficient of Variance	2.340	3.645	1.666	3.206	4.255	2.105	8.897	3.305	2.107	2.625
Phenotypic Coefficient of Variance	3.325	6.066	4.406	5.847	4.751	3.270	11.943	5.668	4.071	3.886
Heritability (Broad Sense)	0.496	0.361	0.143	0.301	0.802	0.414	0.555	0.340	0.268	0.456
Genetic Advance	0.928	2.021	0.261	1.845	0.954	2.811	0.771	0.488	0.239	1.413
Genetic Advance as percentage of mean	3.394	4.512	1.298	3.621	7.851	2.792	13.653	3.970	2.247	3.654

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Table 3c: Genetic correlation between yield and yield related traits

	D50H	GFP	FLL	FLW	PH	SBTPP	CC	CTD	PW	LR
D50H	1 **	0.086	0.153	-0.034	-0.0778	0.4872 **	-0.3334 **	-0.0925	0.005	0.0475
GFP	0.086	1 **	-0.002	0.007	-0.1468	-0.3191 *	0.308 *	0.3452 **	0.0107	0.3574 **
FLL	0.153	-0.002	1 **	0.051	-0.3341 **	0.0999	0.3388 **	0.1735	-0.0078	0.192
FLW	-0.034	0.007	0.051	1 **	-0.1184	-0.0383	0.0396	-0.152	-0.3339 **	-0.2676 *
PH	-0.077	-0.146	-0.334 **	-0.118	1 **	0.0964	0.0832	0.1418	0.1377	-0.3588 **
SBTPP	0.487 **	-0.319 *	0.099	-0.038	0.0964	1 **	-0.0889	0.4802 **	-0.0463	-0.0023
CC	-0.333 **	0.308 *	0.338 **	0.039	0.0832	-0.0889	1 **	0.123	0.037	0.2038
CTD	-0.092	0.345 **	0.173	-0.152	0.1418	0.4802 **	0.123	1 **	0.0489	-0.2196
PW	0.005	0.010	-0.008	-0.333 **	0.1377	-0.0463	0.037	0.0489	1 **	0.3018 *
LR	0.047	0.357 **	0.192	-0.267 *	-0.3588 **	-0.0023	0.2038	-0.2196	0.3018 *	1 **
SL	-0.134	0.055	-0.004	-0.034	0.124	0.0209	-0.0385	0.219	-0.3209 *	-0.1326
NSPS	0.321 *	0.186	0.398 **	0.496 **	-0.2501	0.0607	-0.0629	0.3973 **	-0.3516 **	-0.3271 *
PB	0.206	-0.119	-0.145	-0.409 **	-0.0761	-0.2209	-0.1004	-0.0524	-0.1914	-0.0869
NGPS	0.123	0.174	-0.071	0.206	-0.2755 *	0.0317	0.1038	-0.3888 **	-0.1898	-0.0739
NGPP	0.153	-0.077	0.111	0.073	0.0755	-0.1663	0.4089 **	-0.5105 **	2e-04	0.0769
GL	0.312 *	-0.160	0.370 **	-0.16	0.0732	0.4837 **	0.0246	0.3128 *	-0.0485	0.4356 **
TW	0.119	-0.108	-0.087	-0.038	0.2554 *	0.1065	-0.3087 *	0.057	0.0492	-0.2736 *
GYPP	0.274 *	0.402 **	0.087	0.004	-0.4611 **	-0.0817	-0.0517	-0.2331	-0.1243	0.4638 **
HI	0.051	0.296 *	0.203	0.355 **	-0.2602 *	0.0555	0.0743	-0.092	0.0597	0.3732 **

	SL	NSPS	PB	NGPS	NGPP	GL	TW	GYPP	HI	PC
D50H	-0.1348	0.3215 *	0.2066	0.1232	0.1535	0.3122 *	0.1195	0.2745 *	0.0513	-0.0246
GFP	0.0555	0.1864	-0.1194	0.1746	-0.0773	-0.1601	-0.1085	0.4023 **	0.2964 *	-0.0299

PC	-0.024	-0.029	0.340 **	-0.087	-0.1995	-0.1117	-0.0018	-0.2934 *	-0.1439	0.0491

FLL	-0.0039	0.3979 **	-0.1452	-0.0711	0.1113	0.3703 **	-0.0875	0.0876	0.203	0.3402 **
FLW	-0.0343	0.4968 **	-0.4092 **	0.2063	0.0736	-0.16	-0.0384	0.0042	0.3554 **	-0.0874
PH	0.124	-0.2501	-0.0761	-0.2755 *	0.0755	0.0732	0.2554 *	-0.4611 **	-0.2602 *	-0.1995
SBTPP	0.0209	0.0607	-0.2209	0.0317	-0.1663	0.4837 **	0.1065	-0.0817	0.0555	-0.1117
CC	-0.0385	-0.0629	-0.1004	0.1038	0.4089 **	0.0246	-0.3087 *	-0.0517	0.0743	-0.0018
CTD	0.219	0.3973 **	-0.0524	-0.3888 **	-0.5105 **	0.3128 *	0.057	-0.2331	-0.092	-0.2934 *
PW	-0.3209 *	-0.3516 **	-0.1914	-0.1898	2e-04	-0.0485	0.0492	-0.1243	0.0597	-0.1439
LR	-0.1326	-0.3271 *	-0.0869	-0.0739	0.0769	0.4356 **	-0.2736 *	0.4638 **	0.3732 **	0.0491
SL	1 **	0.7238 **	0.4088 **	-0.1946	-0.6247 **	0.5403 **	-0.5199 **	-0.0559	-0.367 **	-0.1391
NSPS	0.7238 **	1 **	0.562 **	0.0985	-0.0609	-0.7881 **	0.0373	-0.3026 *	-0.5454 **	0.088
PB	0.4088 **	0.562 **	1 **	-0.3137 *	-0.1794	0.0604	0.3479 **	-0.0126	-0.7732 **	0.1339
NGPS	-0.1946	0.0985	-0.3137 *	1 **	0.243	-0.0911 **	0.0663	0.1026	0.2763 *	0.1546
NGPP	-0.6247 **	-0.0609	-0.1794	0.243	1 **	-0.6738 **	-0.1343	0.2132	0.3019 *	0.2701 *
GL	0.5403 **	-0.7881 **	0.0604	-0.0911 **	-0.6738 **	1 **	-0.3373 **	0.7128 **	0.3644 **	0.4734 **
TW	-0.5199 **	0.0373	0.3479 **	0.0663	-0.1343	-0.3373 **	1 **	-0.147	-0.3526 **	0.0274
GYPP	-0.0559	-0.3026 *	-0.0126	0.1026	0.2132	0.7128 **	-0.147	1 **	0.6295 **	0.3767 **
HI	-0.367 **	-0.5454 **	-0.7732 **	0.2763 *	0.3019 *	0.3644 **	-0.3526 **	0.6295 **	1 **	0.1125
PC	-0.1391	0.088	0.1339	0.1546	0.2701 *	0.4734 **	0.0274	0.3767 **	0.1125	1 **

	SL	NSPS	PB	NGPS	NGPP	GL	TW	GYPP	HI	PC

Table 4 : Phenotypic correlation between yield and yield related traits

	D50H	GFP	FLL	FLW	PH	SBTPP	CC	CTD	PW	LR
D50H	1 **	-0.0105	0.023	-0.0472	-0.0821	0.1806 *	-0.1206	-0.0568	-0.0707	0.0357
GFP	-0.0105	1 **	0.1079	0.0197	-0.0791	-0.1143	0.0904	0.0875	0.0219	0.0288
FLL	0.0231	0.1079	1 **	0.0694	-0.1907 *	0.0332	0.171 *	0.1727 *	-0.1058	0.1315
FLW	-0.0472	0.0197	0.0694	1 **	0.0181	-0.1187	0.0464	-0.0778	-0.1605 *	-0.0669
PH	-0.0821	-0.0791	-0.1907 *	0.0181	1 **	0.0353	-0.0386	0.0083	0.0273	-0.1372
SBTPP	0.1806 *	-0.1143	0.0332	-0.1187	0.0353	1 **	-0.0366	0.2106 **	0.0153	-0.0999
CC	-0.1206	0.0904	0.171 *	0.0464	-0.0386	-0.0366	1 **	0.1265	0.0109	-0.0077
CTD	-0.0568	0.0875	0.1727 *	-0.0778	0.0083	0.2106 **	0.1265	1 **	0.0804	0.045
PW	-0.0707	0.0219	-0.1058	-0.1605 *	0.0273	0.0153	0.0109	0.0804	1 **	0.1016
LR	0.0357	0.0288	0.1315	-0.0669	-0.1372	-0.0999	-0.0077	0.045	0.1016	1 **
SL	-0.0176	-0.1012	0.0129	-0.0474	0.0053	-0.0183	-0.0398	0.1088	-0.0048	-0.0956
NSPS	0.0976	-0.0527	0.1298	0.0159	-0.2112 **	0.021	0.0053	0.2083 **	-0.0453	-0.0589
PB	-0.0594	-0.003	-0.0869	-0.13	-0.1204	-0.0923	-0.1099	-0.0075	0.0728	-0.0426
NGPS	-0.0281	0.0151	0.0431	-0.0279	-0.0647	0.0941	0.0383	-0.1371	-0.0745	-0.0068
NGPP	-0.0271	-0.0779	-0.1084	0.1097	0.0172	0.0388	0.1589 *	-0.0862	0.1096	-0.0076
GL	0.1153	-0.0688	-0.0035	-0.0914	-0.045	0.1103	-0.0781	-0.0298	-0.0277	-0.0142
TW	0.0546	-0.0684	-0.1366	-0.0688	0.1005	0.0913	-0.1077	0.0272	0.091	-0.1074
GYPP	0.0652	0.0614	-0.0044	-0.0046	-0.2058 **	1.00E-04	-0.0165	-0.1447	-0.0073	0.1003
HI	0.0691	0.0526	0.0957	0.115	-0.0184	0.051	0.0916	-0.0752	-0.0843	0.108
PC	-0.0369	-0.0153	0.2221 **	-0.0419	-0.1213	-0.0393	0.0111	-0.1718 *	-0.0863	-0.0288

D50H	-0.017	0.097	-0.059	-0.028	-0.027	0.115	0.054	0.065	0.069	-0.036
GFP	-0.101	-0.053	-0.003	0.015	-0.077	-0.068	-0.068	0.061	0.052	-0.015
FLL	0.012	0.129	-0.086	0.043	-0.108	-0.003	-0.136	-0.004	0.095	0.222**
FLW	-0.047	0.016	-0.13	-0.028	0.109	-0.091	-0.068	-0.004	0.115	-0.041
PH	0.005	-0.211 **	-0.120	-0.064	0.017	-0.045	0.101	-0.2058 **	-0.018	-0.121
SBTPP	-0.018	0.021	-0.092	0.094	0.038	0.110	0.091	0.0001	0.051	-0.039
CC	-0.039	0.005	-0.109	0.038	0.158 *	-0.078	-0.107	-0.016	0.091	0.011
CTD	0.108	0.208 **	-0.0075	-0.137	-0.086	-0.029	0.027	-0.144	-0.075	-0.171 *
PW	-0.004	-0.045	0.072	-0.074	0.109	-0.027	0.091	-0.007	-0.084	-0.086
LR	-0.095	-0.058	-0.042	-0.007	-0.007	-0.014	-0.107	0.100	0.108	-0.028
SL	1 **	0.201 **	0.113	-0.089	-0.074	0.108	-0.134	-0.045	-0.129	-0.067
NSPS	0.201 **	1 **	0.310 **	-0.054	-0.053	0.076	-0.065	-0.035	-0.2876**	-0.036
PB	0.113	0.310 **	1 **	-0.118	0.033	-0.005	0.113	0.055	-0.8378**	0.101
NGPS	-0.089	-0.054	-0.118	1 **	0.033	-0.138	0.040	0.034	0.128	0.084
NGPP	-0.074	-0.053	0.033	0.033	1 **	-0.174 *	0.050	0.126	0.040	0.056
GL	0.108	0.076	-0.0057	-0.138	-0.174 *	1 **	-0.036	-0.033	-0.007	0.085
TW	-0.134	-0.065	0.113	0.040	0.050	-0.036	1 **	-0.091	-0.137	0.066
GYPP	-0.045	-0.035	0.055	0.034	0.126	-0.033	-0.091	1 **	0.456 **	0.235**
HI	-0.129	-0.287 **	-0.837 **	0.128	0.040	-0.007	-0.137	0.456 **	1 **	0.019
PC	-0.067	-0.036	0.102	0.084	0.056	0.085	0.066	0.235 **	0.019	1 **

CONCLUSION

The all-yield attributing characters showinghigh genotypic and phenotypic coefficients of variation were observed for plant waxiness, followed by grain yield per plant and leaf rolling. Heritability coupled with genetic advance were identified in yield per plot (g), grain yield ~~/ plant~~ (g~~m~~/plant), plant waxiness (0-10 scale).Correlation studies it could be concluded that characters like Grain yield per plant exhibited significant positive correlation with grain length (mm),harvest index (%), leaf rolling (0-10 scale).Thus, this finding indicated that these traits could utilize in various breeding as well as improvement programmes. The information may further help the breeders in formulating appropriate strategy aimed at getting higher yield and character improvement in Bread wheat.

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