

Studies on Genetic variability and Character Association for Yield and its component Traits in Bread Wheat (*Triticum aestivum* L.)

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ABSTRACT: Wheat is one of the most important staple crops worldwide, providing a significant portion of the global food supply. Understanding and managing wheat variability is crucial for improving varieties and promoting sustainable agriculture, ensuring a stable global food supply. To access variability and understand character association, the present experiment was conducted during the *Rabi season 2022* at the research farm of Department of Genetics and Plant breeding, School of Agriculture, Lovely Professional University, Phagwara, Punjab. The study involved 90 wheat cultivars and 4 standard checks evaluated using Augmented design. Observations were recorded for ten yield and yield attributing traits. The analysis of variance revealed presence of sufficient genetic variability for most of the traits studied. Traits such as spike length, seeds per spike, and no of productive tillers per plant high heritability coupled with high genetic advance. Therefore, these traits can be given priority in future wheat crop improvement programme. The phenotypic correlation analysis revealed that traits such as number of productive tillers per plant (0.6447**), spike length (0.2802**), and seeds per spike (0.4492**) exhibited highly significant positive correlations with grain yield per plant. Traits such as days to maturity, number of productive tillers per plant, spike length, seeds per spike, SPAD and harvest index showed positive and direct effect with grain yield per plant. Traits that exhibit a strong positive correlation and have a high positive direct effect can serve as effective selection criteria for the improvement of future wheat crops.

Keywords: Wheat, Correlation, Path-coefficient, Heritability, Genetic advance.

INTRODUCTION

Wheat is one of the most significant cereal crops worldwide, serving as a staple food for a substantial portion of the global population. Wheat, scientifically referred to as *Triticum aestivum* L., is a type of crop that reproduces through self-pollination and belongs to the *Poaceae* family. It is categorized as a segmental allohexaploid species with a chromosome count of $2n = 6x = 42$. Wheat originates from Southwest Asia, where it is indigenous (Filiz, 2012 ; Baenziger, 2016). Wheat kernels possess significant nutritional value, consisting of approximately 70-75% starch, 14% water, 8-20% proteins, 2-3% non-starch polysaccharides, 2% lipids, and 1.6% minerals, along with various antioxidants (Goesaert *et al.*, 2005). It is extensively cultivated and serves as India's second-largest food crop, following rice, in terms of both cultivation area and production. Due to its wide cultivation area, substantial production, and significant role in global grain trade, it is popularly known as the "King of Cereals". Wheat is cultivated across an area of 33.61 million hectares in India, yielding an output of approximately 106.21 million metric tonnes with a productivity rate of 3160 kg/ha in the 2019–20 season (FAO, 2020). Specifically in Punjab, wheat was sown across 35.1 lakh hectares, resulting in a harvest of 171 lakh metric tonnes with a productivity of 1197 kg/ha during the 2020–21 season.

The exploration of genetic variability in wheat holds tremendous promise for improving crop performance, resilience, and quality. By identifying and utilizing diverse genetic resources, breeders can develop cultivars that are well-suited to specific environments, possess enhanced disease resistance, exhibit superior nutritional attributes, and meet the demands of diverse end-use applications. Plant breeders may anticipate the characteristics of future generations through knowing the heritability of a trait, which helps them choose desirable features for their breeding programmes. Traditional analysis of variance and statistical tools like phenotypic and genotypic coefficients of variability, heritability, and genetic advance have been used to quantify the degree and nature of variation in wheat breeding material (Rahman *et al.*, 2016). In order to more precisely estimate the relationship between different traits and grain yield, correlation and path analysis both provide better approaches. When determining the degree and direction of the association between different yield-contributing traits and the ultimate yield results, correlation analysis is useful. The path coefficient, often referred to as the standardised partial regression coefficient, is a measurement of the direct effect of a predictor variable on corresponding response variables. The indirect effects of the predictor variable(s) are also included in the second component (Kumar *et al.*, 2019). For breeders Knowledge of association between various trait and the yield of crops,

including both the direct and indirect effects that each trait contributes helps breeders to establish effective criteria for selecting desirable genotypes.

In considering the factors mentioned above, the aim of this study was to investigate the magnitude of variability seen in the yield and yield attributing traits of bread wheat. This research also sought to study the character association along with their direct and indirect effect, of different morpho-physiological traits on the yield of the crop (Dewey and Lu 1959).

MATERIALS AND METHODS

The present experimental research was conducted at the experimental area of the Department of Plant breeding and genetics, School of agriculture, Lovely Professional University, Jalandhar, Punjab during *Rabi season*, 2022. The experimental material of present study comprised of 90 wheat cultivars and 4 standard checks evaluated using Augmented design. The field was divided in 6 blocks of equal plots. Each entry was raised in two rowed plots with row to row and plant to plant spacing of 22.5 cm and 5 cm, respectively. In order to guarantee a high-quality crop, we diligently followed all suggested conventional farming methods and implemented essential precautionary measures to protect the plants from potential threats. Observations on yield and yield attributing characters were recorded for ten characters *viz.* days to 50% flowering (DFF), days to maturity (DM) plant height (PH), number of productive tillers per plant (NPT), spike length (SL), seeds per spike (SPS), thousand grain weight (TGW), grain yield per plant (GYP), SPAD value (SPAD and harvest index (HI). With the aim of accessing the variability parameters, the association for different traits along with their direct and indirect effects. The statistical analysis for the mean performance of each trait was done by method given by Federer (1956). The GCV and PCV was estimated as per formula proposed by Burton and Devane (1953). Heritability in terms of broad sense (bs) was evaluated by formula given by Hanson *et al.* (1956). The genetic advance was evaluated using the method proposed by Johnson *et al.* (1958). The correlation studies among the different traits were evaluated using the method proposed by Miller *et al.* (1955). The direct and the indirect effects on grain yield per plant was evaluated using the method proposed by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance for ten traits studied in wheat genotypes indicated that the treatment was significant for all the characters studied indicating that there was considerable genetic variation present in the material studied. The result from the analysis of variance of all character under the study have been given in Table 1. Similar kind of results were also found by Sethi *et al.* (2020); Gerema *et al.* (2020); Bhanu *et al.* (2018).

Variability parameters. The results of variability parameters which includes GCV, PCV, heritability, genetic advance, and genetic advance as percentage of mean, were calculated for 10 traits and are presented in Table 2, Fig 1. In present study, the phenotypic

coefficient of variation was greater than genotypic coefficient of variation for all the traits. It means the observed variation is not only due to the genotypes, but also due to influence of environment. High GCV and PCV was observed in the spike length (25.36, 27.08), seeds per spike (23.44, 24.56) and grain yield per plant (21.67, 23.21). Similar kind of results for grain yield per plant were found in Kumar *et al.* (2017). Medium GCV and PCV was observed in plant height (16.26, 18.54) and SPAD value (15.3, 18.25). Similar kind of result for plant height were found in Reddy *et al.* (2020), for number of productive tillers per plant was found by Sethi *et al.* (2020) and for SPAD value by Thapa *et al.* (2019); Kumar *et al.* (2017). Low GCV and PCV was observed in days to 50% flowering (7.91, 8.63), days to maturity (5.43, 6.59) and harvest index (6.41, 8.17). Low GCV and Medium PCV was observed in thousand grain weight (8.82, 11.86) with similar kind of findings from Reddy *et al.* (2020); Kumar *et al.* (2017). Low PCV and low GCV indicates less scope of selection considering these traits as these are under environmental influence. The results of heritability, genetic advance as percentage of mean is presented in Table 2, Fig 2. Traits *viz.*, number of productive tillers per plant, spike length and seeds per spike showed high heritability along with the high genetic advance as percentage of mean. The presence of high heritability coupled with high genetic advance suggests that there is significant potential for genetic enhancement through selective breeding for all of these traits. Furthermore, the observed pattern indicates that the inheritance of these traits is largely influenced by additive gene action, implying that selection can effectively improve these traits in early generations. Similar kind of findings were found in Thapa *et al.* (2019); Kumar *et al.* (2017) for the traits like number of productive tillers and seeds per spike, Kumar and Kumar (2021) for the trait spike length. The traits like plant height, grain yield per plant and harvest index showed high heritability along with moderate genetic advance as percentage of mean. Similar kind of findings were found in Devesh *et al.* (2018) for the traits like plant height and grain yield per plant, Kumar and Kumar (2021); Sethi *et al.* (2020) for the trait harvest index. This suggests that the additive and non-additive gene effects on the traits hindering further improvement.

Correlation Coefficient Analysis. The most common method to evaluate the direction and degree of the relationships between variables is correlation. Understanding correlations is essential for any crop improvement programme since crop yield is a complex quantitative trait that is polygenetically controlled. The correlation coefficients were estimated among all the characters to find out the association of grain yield per plant at the phenotypic level. The phenotypic correlation coefficients of different traits are presented in Table 3 and Fig 3. The phenotypic correlation coefficient analysis for 10 traits, where number of productive tillers per plant (0.6447**), spike length (0.2802**) and seeds per spike (0.4492**) showed highly significant positive correlation with grain yield

per plant. SPAD (0.2351*) showed significant positive correlation with grain yield per plant. Days to 50% flowering (-0.2777**) showed highly significant negative correlation with grain yield per plant. Similar kind of findings were found in Dagade *et al.* (2020); Dutamo *et al.* (2015), for the traits like spike length, seeds per spike and days to 50% flowering, Kumar and Kumar *et al.* (2021); Gerema *et al.* (2020) for the traits like number of productive tillers per plant, Bhanu *et al.* (2018) for the traits like SPAD value. A positive correlation between desirable characters is helpful to the plant breeder because it helps in simultaneous improvement of both the characters. Negative correlation on the other hand, will hinder the simultaneous expression of both characters. Therefore, selection of traits like number of productive tillers per plant, spike length, seeds per spike will be extremely influential in improving the grain yield.

Path coefficient analysis. This analysis measures the direct and indirect contributions of different independent characters on a dependent character. Path coefficient analysis reveals that the relative contribution of causal factor towards the grain yield per plant. The

direct or indirect effect of 10 characters on grain yield per plant estimated by phenotypical path coefficient is presented in Table 4 and Fig 4. In the present study, out of 10 traits, six traits have a direct positive effect on grain yield per plant *viz.* days to maturity (0.5853), number of productive tillers per plant (0.5407), spike length (0.0829), seeds per spike (0.1276), SPAD (0.0669) and harvest index (0.0881). Thus, by selecting these traits brings overall improvement in grain yield directly. Similar kind of findings were observed in Devesh *et al.* (2021) for the traits like days to maturity, number of productive tillers per plant, spike length, seeds per spike and harvest index for the trait SPAD value. The remaining three characters have shown direct negative effect on grain yield per plant *viz.* days to 50% flowering (-0.6035), plant height (-0.0202), thousand grain weight (-0.0487). Similar kind of findings were observed in Rajput *et al.* (2018) for the traits like days to 50% flowering and plant height, for the trait thousand grain weight. Selection through negative direct effects is unproductive on grain yield per plant.

Table 1: Analysis of variance for yield and its component traits in bread wheat.

Source	Df	DFF	DM	PH	NPT	SL	SPS	TGW	GYP	SPAD	HI
Treatment (ignoring Blocks)	93	27.92*	18.32*	52.19**	4.12**	27.31**	150.27**	19.31*	28.19**	13.13*	12.42**
Treatment: Check	3	56.93*	126.04**	101.33**	1.05	1.88	32.43	3.12	133.04**	10.73	5.07
Treatment: Test	89	22.34	9.72	45.41**	4.27**	1.8	72.32**	20.05*	9.31	9.19	9.58*
Treatment: Test vs. Check	1	438.06**	460.62**	508.42**	0.01	7.26*	7441.89**	1.82	1393.46**	371.04**	286.95**
Block (eliminating Treatments)	5	15.78	14.84	11.48	0.38	1.65	24.79	7.91	2.72	5.14	3.65
Residuals	15	12.8	8.24	9.16	0.75	1.44	10.89	8.97	4.66	5.4	3.7

ns P > 0.05; * P <= 0.05; ** P <= 0.01

DFF: Days to 50% flowering, DM: Days to Maturity, PH: Plant Height, NPT: Number of Productive tillers, SL: Spike Length: SPS: Seeds per Spike, TGW: Thousand Grain Weight, GYP: Grain Yield per Plant, SPAD: Spad value, HI: Harvest index.

Table 2: Genetic variability parameters for yield and its component traits in bread wheat.

Trait	Range		Mean	CV	GCV	PCV	Heritability (h ²) (%)	Genetic advance	Genetic Advance Mean %
	Minimum	Maximum							
Days to 50% flowering	90.87	107.87	100.23	4.6	7.91	8.63	76.43	8.89	8.87
Days to maturity	125.54	143.17	134.82	3.12	5.43	6.59	71.26	7.82	5.8
Plant height	82.91	120.05	96.25	6.29	16.26	17	79.83	11.1	11.53
Number of productive tillers	7.24	17.11	11.14	7.75	16.84	18.54	82.54	3.52	31.56
Spike length	6.49	13.96	11.09	10.73	25.36	27.08	89.38	4.54	40.93
Seeds per spike	42.00	79.77	58.31	7.35	23.44	24.56	84.94	14.9	25.56
Thousand grain weight	30.34	52.79	37.75	7.92	8.82	11.86	55.29	5.11	13.53
Grain yield per plant	16.78	38.37	23.1	8.79	21.67	23.21	88.73	4.15	17.96
SPAD	29.56	44.58	36.76	6.19	15.3	18.25	81.27	3.58	9.74
Harvest index	31.01	44.81	37.87	4.99	6.41	8.17	70.42	3.92	10.36

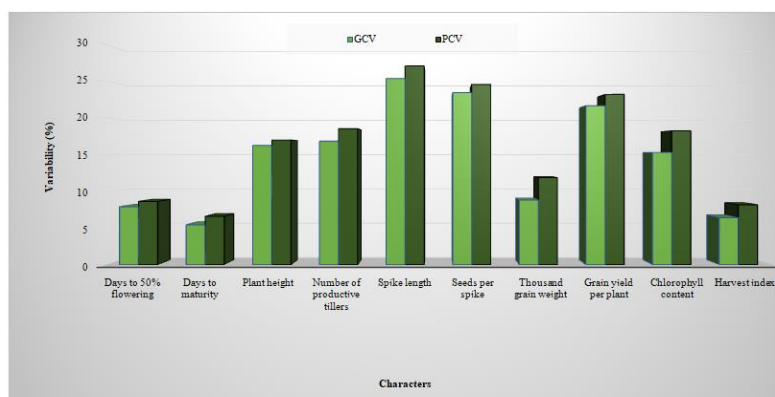


Fig. 1. Estimates of GCV and PCV for yield and its component traits in bread wheat.

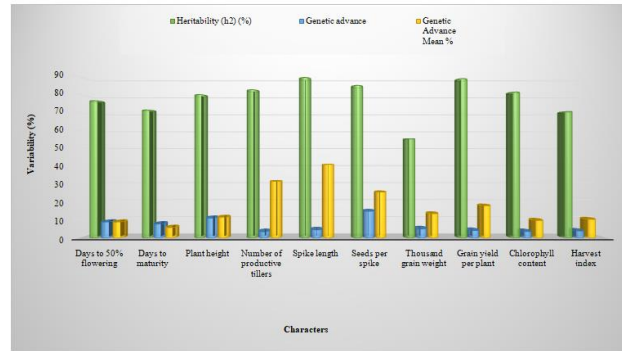


Fig. 2. Estimates of h^2 (bs) (%), GA and GAM for yield and its component traits in bread wheat.

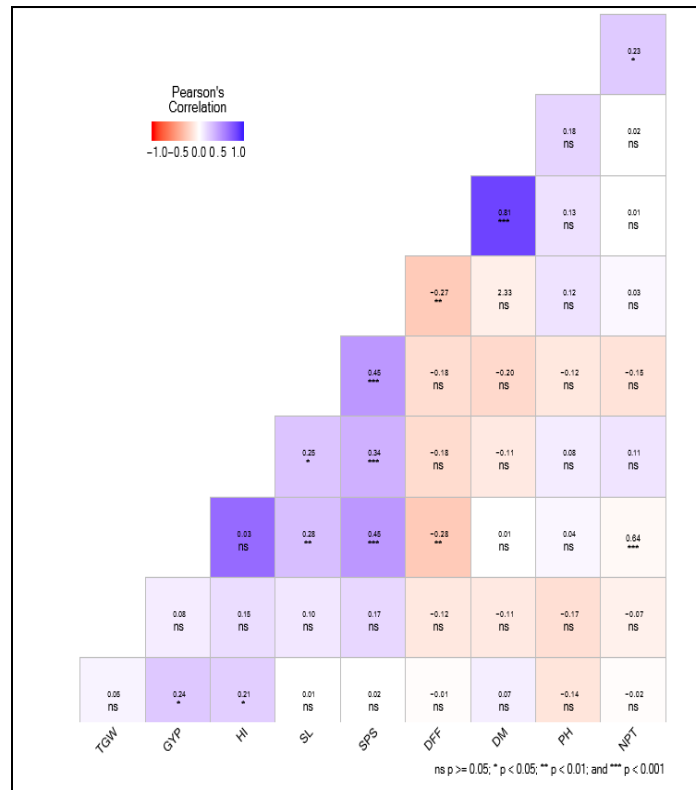


Fig. 3. Phenotypic Correlation for yield and its component traits in bread wheat.

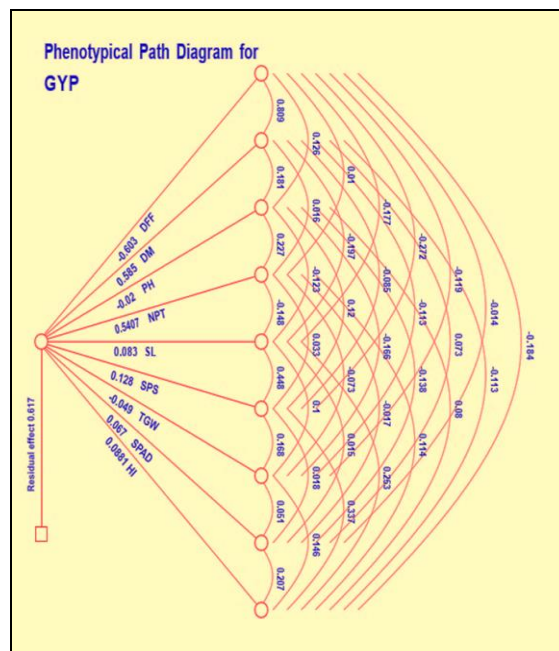


Fig. 4. Phenotypic path diagram for yield and its component traits in bread wheat.

Table 3: Phenotypic correlation coefficient for yield and its component traits in bread wheat.

Trait	DFF	DM	PH	NPT	SL	SPS	TGW	SPAD	HI	GYP
DFF	1	0.809**	0.1259	0.0101	-0.1772	-	-0.1186	-0.0143	-0.1844	-
DM		1	0.1811	0.0156	-0.1971*	-0.0846	-0.1132	0.0726	-0.1132	0.0141
PH			1	0.2272*	-0.1229	0.1198	-0.1658	-0.1381	0.0796	0.0368
NPT				1	-0.1478	0.0331	-0.0727	-0.0171	0.1141	0.6447**
SL					1	0.4482**	0.0997	0.0146	0.2531*	0.2802**
SPS						1	0.1682	0.0178	0.3367**	0.4492**
TGW							1	0.0508	0.146	0.0784
SPAD								1	0.2069*	0.2351*
HI									1	0.0336
GYP	-0.2777**	0.0141	0.0368	0.6447**	0.2802**	0.4492**	0.0784	0.2351*	0.0336	1

** : 1% Level of Significance * : 5% Level of Significance

DFF: Days to 50% flowering, DM: Days to Maturity, PH: Plant Height, NPT: Number of Productive tillers, SL: Spike Length: SPS: Seeds per Spike, TGW: Thousand Grain Weight, GYP: Grain Yield per Plant, SPAD: Spad value, HI: Harvest index.

Table 4: Path Coefficient analysis for yield and its component trait in bread wheat.

Traits	DFF	DM	PH	NPT	SL	SPS	TGW	SPAD	HI
DFF	-0.6035	-0.4882	-0.076	0.1113	0.1069	0.1642	0.0716	0.0086	0.0061
DM	0.4735	0.5853	0.106	-0.0663	-0.1154	-0.0495	-0.0663	0.0425	-0.0091
PH	-0.0025	-0.0037	-0.0202	-0.0016	0.0025	-0.0024	0.0033	0.0028	0.0046
NPT	-0.0009	-0.0014	-0.02	0.5407	0.013	-0.0029	0.0064	0.0015	0.0122
SL	-0.0147	-0.0163	-0.0102	-0.01	0.0829	0.0371	0.0083	0.0012	-0.0042
SPS	-0.0347	-0.0108	0.0153	0.021	0.0572	0.1276	0.0215	0.0023	-0.0035
TGW	0.0058	0.0055	0.0081	0.043	-0.0049	-0.0082	-0.0487	-0.0025	0.0011
SPAD	-0.001	0.0049	-0.0092	-0.0071	0.001	0.0012	0.0034	0.0669	-0.0617
HI	-0.0997	-0.0612	0.043	0.0138	0.1369	0.182	0.079	0.1119	0.0881
GYP	-0.2777	0.0141	0.0368	0.6447	0.2802	0.4492	0.0784	0.2351	0.0336

R SQUARE = 0.6191 RESIDUAL EFFECT = 0.6172

Note: Bold figure indicates direct effects.

DFF: Days to 50% flowering, DM: Days to Maturity, PH: Plant Height, NPT: Number of Productive tillers, SL: Spike Length: SPS: Seeds per Spike, TGW: Thousand Grain Weight, GYP: Grain Yield per Plant, SPAD: Spad value, HI: Harvest in

CONCLUSIONS

Therefore, based on the present findings, it can be concluded that genotypes utilized in this study exhibits substantial variability for a majority of the traits. Consequently, it is crucial to consider these traits during the selection process to identify superior individuals. These traits should be prioritized in the selection of plants for further improvement of yield and yield-related traits in bread wheat. Traits such as productive tillers per plant, spike length and seeds per spike and SPAD value showing significant and positive correlation with grain yield per plant. So, these traits can be used for effective selection in future crop improvement programme.

FUTURE SCOPE

Based on above findings, the future scope lies in utilizing the identified traits for effective selection in wheat crop improvement programs. By using advanced breeding techniques and considering multiple traits together, we can develop wheat varieties that have high yielding, resilient to climate change and nutritionally enriched, thus ensuring a sustainable and reliable global food supply.

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Conflict of Interest. None.

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