Genetic analysis, correlation and path coefficient analysis among yield and yield attributing traits in wheat (*Triticum aestivum* L.) genotypes

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ABSTRACT

A study was undertaken to estimate the genetic variability, correlation and path coefficient analysis of yield and yield contributing traits in fourteen wheat cultivars grown in randomized block design with three replications at Agriculture Research Farm, Department of Genetics and Plant Breeding, Rabindranath Tagore University, Bhopal M.P. during *rabi*2020-21, to estimate the genetic variability and correlation coefficient and path analysis of yield and yield contributing traits in fifty four genotypes. The analysis of variance revealed that the treatments were highly significant for all the characters. The higher magnitudes of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for grain yield per plant, biological yield per plant, number of tillers per plant, harvest index, number of grains per ear and 1000-grain weight respectively. The high heritability in broad sense was estimated for all the characters. High value of heritability indicates that it may be due to higher contribution of genotypic components. High heritability coupled with high genetic advance as percent of means were recorded for tillers per plant, number of ears per plant, number of grains per ear, 1000-grain weight, biological yield per plant, grain yield per plant and harvest index. The correlation coefficients estimate showed high direct genotypic and phenotypic correlations for all the traits studied except 1000-grain weight. Path analysis showed that biological yield had the highest direct positive effect on grain yield followed by harvest index, 1000-grain weight and tillers per plant thereby indicated that these were main contributors to the grain yield. Therefore, these traits may be effective in selection during breeding programme for improving grain yield and quality.

Keywords: Genetic variability, correlation coefficient, Genotypic and phenotypic, Path coefficient, Wheat

Introduction

Bread wheat (*Triticum aestivum* L. em Thell. 2n = 6x = 42) is a self-pollinating annual plant belonging to the family Poaceae. Being the largest cereal crop, it is known as the ”king of cereals” due to high productivity and prominent position it holds in the international food grain trade. To satisfy the demands of the increasing population all over the world, increase in production has become a major priority over the years.

Information regarding the existing genetic variability among the genotypes forms the basic requirement for selection. In order to improve production, grain yield plays a vital role. However, grain yield is a polygenic trait which is influenced by many genetic and environmental factors therefore direct selection of yield can lead to errors.

Various morphological traits are taken into consideration which helps to study the association between the grain yield and hence results in effective selection. Correlation coefficient is an important statistical method which helps to select the best high yielding genotype by studying the strength of relationship among the considered traits as well as the magnitude and direction during selection. However simple correlation is not sufficient to provide the required information about the contribution of each character towards yield. Therefore, path coefficient analysis is utilized which separates the direct effects from the indirect effects through other related characters (Dewey and Lu, 1959).

Hybridization efforts that aim to create high yielding progeny have been viewed as dependent on several factors, one of the most crucial being the extent of genetic variability. Understanding about variability is important for plant breeders as it allows them to foresee how offspring will behave, make good selection decisions, and evaluate the extent to which genetic improvement has been achieved through selective breeding. Better genetic progress and more accurate estimates of heritability demonstrate selection's capacity to create novel genotypes with improved qualities. Therefore, estimates of heritability in this study would aid in forecasting the potential progress that can be achieved by optimizing the selection process. Moreover, genetic advance estimates give a clear picture of F1 generation to make selection effective. This study is aimed to estimate variability and genetic parameters for yield components

Materials and Methods

The experimental material was comprised of fifty-four genotypes (forty F1 populations and 14 parental genotypes). The parental genotypes are GW-273, GW-322, GW-366, JW-1201, JW-1202, JW-1203, LOK-1, HD-2864, HD-2932, HI-1544, JW- 3336, JW-3288, MP-3269, JW-3211. The experiment was carried out under Agriculture Research Farm, Department of Genetics and Plant Breeding, Rabindranath Tagore University, Bhopal M.P. during *rabi* 2020. The F1 Seeds and parents were grown in lines keeping plant to plant distance at 10cm and row to row distance at 20cm. All the crop protection measures were adopted on time. Data were collected for Days to 50% heading, Days to maturity, plant height, Number of tillers per plant, number of spikelets per ear, Number of ears per plant, Number of grains per ear, 1000-grain weight, biological yield per plant, Grain yield per plant and Harvest index. At maturity, five healthy and competitive plants from each F1 cross and each parent were taken at random and data were recorded and analyzed. Further, the value of harvest index was calculated as per the formula given by Donald and Humblin (1976).

The mean performance of individual genotypes was embayed for statistical analysis. Analysis of variance to test the significance for each character was carried out as per methodology given by Panse and Sukhatme (1967). Genotypic and phenotypic coefficients of variation (GCV and PCV) were calculated by the formula given by Burton (1952), heritability in broad sense (h^2) by Burton and Vane (1953) and genetic advance given by Johnson *et al.* (1955).

Correlation coefficient and path coefficient was worked out as method suggested by Al-Jibouri *et al.* (1958) and Dewey and Lu (1959), respectively.

Table 1: Analysis of variance for yield and yield attributing traits

S.V.	D.F	Days to 50% Flowering	Days to Maturity	Plant Height	Tillers/ Plant	Spikelets/ Ear	Ears/ Plant	Grains/ Ear	1000-grain Weight	Biological Yield/ Plant	Grain Yield/ Plant	Harvest Index
Replication	2	3.081	0.11	0.67	0.12	0.02	0.10	0.22	1.66	9.11	0.37	4.44
Treatments	53	11.86**	20.39**	38.71**	3.18**	6.05**	12.03**	72.97**	32.46**	472.75**	54.91**	31.58**
Error	106	2.02	1.63	1.09	0.65	0.51	0.52	2.31	0.56	4.94	1.03	1.45

Table 2: Genetic parameters of variability for yield and yield attributing traits in wheat

Characters	Grand mean	Range		Coefficient of variation		H^2 (bs)	GA as per cent of mean
		Min	Max	GCV	PCV		
Days to 50% heading	70.42	66.00	73.66	2.57	3.27	62	2.93
Days to maturity	117.81	113.33	122.66	2.12	2.38	79	4.59
Plant height	76.21	66.30	85.00	4.65	4.85	92	6.99
Tillers/plant	13.97	11.56	16.81	14.02	14.94	88	3.78
Spikelets/ ear	19.20	16.32	22.20	7.08	8.00	78	2.48
Ears/plant	11.41	9.5	13.9	8.05	10.72	56	1.42
Grains/ear	56.29	43.89	64.48	8.62	9.04	91	9.54
1000-grain weight	38.18	32.96	44.00	8.54	8.76	95	6.55
Biological yield/plant	67.10	46.29	94.10	18.61	18.90	97	25.33
Grain yield/plant	22.42	13.55	30.15	18.90	19.44	95	10.49
Harvest index	33.49	28.99	42.61	9.46	10.12	87	6.10

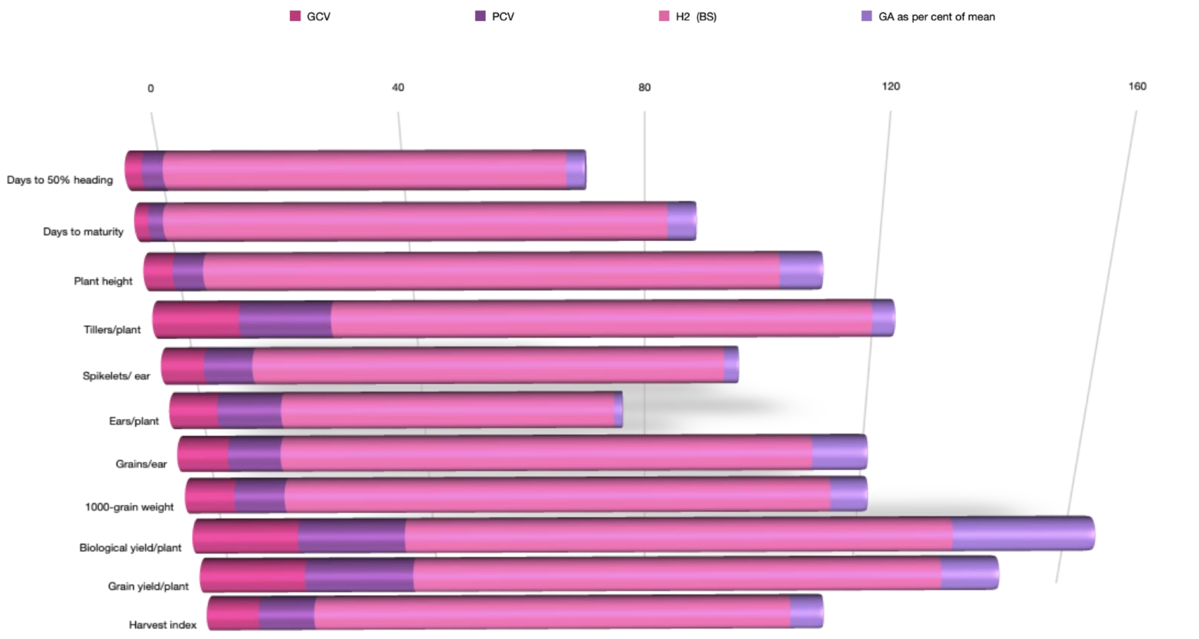

Fig 1: Representing GCV, PCV, h^2 (broad sense) and genetic advancement (GA)

Results and Discussion

To know the extent of variation for observed characters among the genotypes of wheat, analysis of variance was performed and presented in **table 1.** Results of analysis of variance indicated that the mean sums of squares due to genotypes were highly significant for all the traits under study, suggesting presence of sufficient variation among the genotypes for these traits. Maximum variability was observed for biological yield per plant (472.75). The magnitude of variability in decreasing order for other traits were as follows: number of grains per ear, grain yield per plant, plant height, 1000-grain weight, harvest index, days to maturity, number of ears per plant, days to 50% heading, number of spikelets per ear and number of tillers per plant. The variability among parental lines and F1s ranged from biological yield per plant to 1000-grain weight. This was in conformity with the findings of Ahmed et al. (2015), Ali et al. (2008), Singh et al. (2015).

Mean and range performance for yield component characters are illustrated in **table 2.** The character days to 50% flowering ranged from 66.00 to 73.66 days with an average of 70.42 days. Days to maturity varied from 113.33 to 122.66 days with mean of 117.81 days. Among all 54 genotypes, GW 273 (Line) and JW 3288 (Tester were earliest in maturity, while HD 2932 (Line) and JW 3211 (Tester) matured late. Whereas, among the hybrids, GW 273 X JW 3336 was earliest in maturity, while HD 2864 X MP 3269 matured late. Number of tillers per plant had an average performance of 13.97 with a range of 11.57 to 26.81. Number of spikelets per ear was recorded in the range of 16.32 to 22.20 with an average at 19.20. Number of ears per plant showed a mean value 11.41 and varied from 9.53 to 13.97. Number of grains per ear showed a variation ranging from 43.90 to 64.48 with a mean value of 56.29. 1000- grain weight recorded a minimum value of 32.97 g and a maximum of 44.00 g with a mean value of 38.18 g. Range of variation observed for biological yield per plant was 46.30 g to 94.11 g with mean value of 67.10 g. Grain yield per plant recorded a minimum value of 13.56 g and a maximum of 30.15 g with a mean value of 22.42 g. Harvest index showed a variation ranging from 28.99% to 42.62% with a mean value of 33.49%.

Correlation coefficient is used to determine the component characters which are positively correlated to yield on which selection can be done for genetic yield improvement. Correlation helps breeders to develop the best high yielding plant type by studying the extent of association between different morphological characters. Phenotypic coefficients of variation estimates were higher than the genotypic coefficients of variation for all characters under study. Grain yield per plant recorded the moderate PCV (19.44) and GCV (18.90) followed by biological yield per plant (18.90, 18.61); number of tillers per plant (14.94, 14.02). Number of ears per plant (10.72%, 8.05%) and harvest index (10.12%, 9.46%) showed moderate PCV but low GCV, respectively, suggesting sufficient variability are available and thus exhibited scope for genetic improvement through selection for all these traits. These findings were agreement with Ghimiray and Sarkar (2000), Tripathi et al. (2009) and Bisht and Gahalain (2009). These values alone are not helpful in determining the heritable portion of variation. The proportion of genetic variability which is transmitted from parents to all spring is reflected by heritability (Lush, 1949).

To determine the expression of a trait, role of heredity and environment is very essential therefore heritability is considered as an important quantitative parameter (Allard, 1960). Heritability and genetic advance are important selection parameters. Heritability estimate along with genetic advance are normally more helpful in predicting the gain under selection than heritability alone. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance. Results showed that all the characters expressed high estimates of heritability except number of tillers per plant (56.31%). It indicates that the heritability is most likely due to additive gene effect and selection may be effective. The high genetic advance as percentage of mean was showed by biological yield per plant (25.33% indicated predominance of additive gene action for controlling these characters. Thus, simple selection can be practiced to improve these characters. This was in consonance with the findings of Fikre et al. (2015), Hassan et al. (2013), Fellahi et al. (2013) and Saxena et.al (2017).

Path coefficient analysis is an important tool for partitioning the correlation coefficients into the direct and indirect effects of independent variables on a dependent variable. It is also important to understand the relative importance of different parameters as selection criteria. It helps to better understand the interrelationship among the traits. Grain yield is complex character for its improvement multiple traits to be considered. Bold diagonal values are direct effect of independent characters, off-diagonal values are indirect effects of each character via other character is shown in table 3. If the correlation between yield and character is due to the direct effects of character, it reflects true relationship between them, selection can be practiced for such a character in order to improve yield. However, if correlation is due to indirect effect of the character through another component trait; the breeder must select for the latter trait through which indirect effect is exerted. The traits like biological yield per plant, harvest index, number of spikelets per ear , number of tillers per plant, 1000-grain weight, plant height, days to 50% heading contributed to the positive direct effect on grain yield per plant.

Table 3. Genotypic path table showing direct and indirect effect of various traits on wheat yield

	X1	X2	X3	X4	X5	X6	X7	X8	X9
X1	**0.012**	0.009	0.004	0.001	0.001	0.001	-0.001	-0.002	0.
X2	-0.061	**-0.082**	-0.024	0.002	-0.006	-0.006	0.000	0.011	-0.
X3	0.006	0.005	**0.017**	-0.002	0.005	-0.001	0.004	0.0002	0.
X4	0.003	-0.001	-0.006	**0.043**	0.013	0.030	0.011	0.005	0.
X5	0.015	0.019	0.086	0.080	**0.276**	0.043	0.267	0.014	0.
X6	-0.002	-0.004	0.004	-0.039	-0.009	**-0.055**	-0.009	-0.004	-0.
X7	0.012	0.000	-0.047	-0.047	-0.187	-0.032	**-0.193**	-0.019	-0.
X8	-0.005	-0.003	0.000	0.003	0.001	0.002	0.003	**0.025**	-0.
X9	0.270	0.309	0.329	0.194	0.253	0.186	0.221	-0.131	**0.**
X10	-0.044	0.006	0.141	-0.128	0.045	-0.133	0.036	0.124	-0.

Residual effect = 0.0208 Bold diagonal values are direct effect of independent characters, off-diagonal values are indirect effects of each character via other character.

rGYi = Genotypic correlation between yield (dependent trait) and its i^{th} independent traits.

x1- days to 50% flowering, x2- days to maturity, x3- plant height, x4- tillers per plant, x5- spikelets per ear length, x6- ears per plant, x7- grains per ear, x8- 1000-grain weight, x9- biological yield per plant, x10- harvest index, x11- grain yield per plant.

In order to find out the cause and effect relationship between grain yield per plant and its component traits, path analysis was taken up in the present investigation and the result indicated that the highest positive direct effect on grain yield per plant was observed for biological yield per plant followed by harvest index, number of spikelets per ear, number of tillers per plant, 1000-grain weight, plant height and days to 50% heading. It indicates true relationship between them and direct selection for these traits will be rewarding for yield improvement. Whereas, highest negative direct effect on grain yield per plant was observed by number of grains per ear, followed by days to maturity, number of ears per plant. It indicates that the restricted selection model should be used for nullification of undesirable effect of these traits.

The current research concludes that direct selection for traits like biological yield per plant, harvest index, number of spikelets per ear, and plant height will be beneficial for yield improvement because these characteristics have a positive direct effect on grain yield per plant.
Traits like these also demonstrated the presence of substantial variations among wheat genotypes for all characters tested, providing plant breeders with an opportunity to enhance these traits through breeding.

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