Original Research Article

Genetic Variability and Character Association Analysis for Seed yield and Its Attributes in Wheat (*Triticum aestivum* L.)

Abstract

Aims: To study the genetic variability and characters association analysis of eighty-two wheat genotypes

Study design: Augmented block design in five blocks

Place and Duration of Study: Research Farm, Rani Lakshmi Bai Central Agricultural University, Jhansi, during *Rabi* season 2019-20

Methodology: Eighty-two genotypes including three checks (HI1544, DBW110, and GW322) observed its various quantitative traits for genetic variation, heritability, genetic advance, and character association. The observations were recorded on fifteen agro-morphological and physiological characters *viz*; days to 50 percent heading, days to maturity, canopy temperature (^{o}C), chlorophyll content, flag leaf width (cm), flag leaf length (cm), tillers per meter, peduncle length (cm), plant height (cm), spike length (cm), awn length (cm), 1000-grain weight (g), grain yield per plant (g), biological yield per plant (g) and harvest index (%).

Results: The genotypes IC443619, IC6165734, and IC624496 were having earlier days to maturity than the best check DBW110. HD3086, K0307, PBW343, RAJ3,765, and MACS6478 have been found promising for grain yield per plant. The highest Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV) was recorded for tillers per plant followed by awn length, peduncle length, flag leaf length, flag leaf width, plant height, and spike length. Heritability in broad sense wide ranged from 26.30 percent for canopy temperature to 95.63 percent for grain yield per plant. The grain yield per plant showed a positive and significant correlation with biological yield per plant, harvest index, and tillers per meter, whereas it showed a negative significant association with awn length.

Conclusion: The relationship between grain yield per plant and biological yield per plant, harvest index, and tillers per metre was positive and significant, indicating that an increase in these component characteristics will also boost economic grain yield per plant.

Keywords: Heritability, Genetic advance, Phenotypic and genotypic coefficient of variation, Correlation

1. Introduction

Wheat is commonly called as the "King of Cereals" due to its prominent position in the international food grain trade and its high acreage, production, and productivity. Wheat, the first domesticated food crop since 8000 years, is the stable food for various civilizations throughout the world. It originated from South-Western Asia and Central Asia and the Mediterranean and Ethiopian regions are centers of diversity for wheat and its related species. There are 17 different species of wheat among which three species *viz.*, hexaploid bread wheat (*Triticum aestivum*), *Triticum durum* (tetraploid macaroni wheat) and tetraploid emmer wheat (*Triticum dicoccum*) are mostly cultivated and consumed throughout the world (Mishra *et al*., 2019). In the world, wheat occupies an area of 217 million ha (Mha) with a total production of 765 million tonnes (Mt) and productivity of 3530 kg/ha (USDA, 2020). China has maximum productivity followed by India, Russia, and USA. In India area, production and productivity of wheat were tremendously increased since the green revolution of 1967. During 2019-20, 3rd estimation India occupies an area of 30.55 million ha with a total production of 107.17 million tonnes and productivity of 3508 kg/ha. Uttar Pradesh leads in an area of 9.35 Mha with a production of 32.09 Mt and a productivity of 3432 kg/ha in the country and Madhya Pradesh occupies the wheat area of 6.02 Mha with a production of 18.58 Mt and a productivity of 3083 kg/ha (DAC&FW, 2020).

Wheat can be used to convert into innumerable products like chapatis, breads, cakes, biscuits, pasta, and many hot and ready-to-eat breakfast foods and is considered a nature's unique gift to mankind (Sharma and Gujral, 2014). Improvement in any crop is possible through an effective breeding program which generally depends on the selection of suitable genotypes, the presence of variation within the population for different economic characteristics is required (Islam *et al.*, 2004). Therefore, the information on genetic diversity in terms of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advance, and genetic divergence is therefore of vital importance. The selection of desirable genotypes can be achieved through the proper characterization of available genotypes. The

estimation of the correlation coefficient is of greater value to determine the nature and degree of relationship between different agro-morphological traits. Knowledge of this inter-relationship between the different characters is useful for breeders to improve selection performance.

With this background, the present investigation was undertaken to examine the genetic variability, heritability, genetic advance, and correlation in respect to various desirable characters in eighty-two genotypes of wheat. The acquired information will assist in recognizing promising lines for the hybridization programme to explore wheat varieties of high-yielding potential coupled with quality.

2. MATERIALS AND METHODS

Eighty-two genotypes including three checks (HI1544, DBW110, and GW322) observed its various quantitative traits for genetic variation, heritability, genetic advance, and character association. This investigation was conducted at Research Farm, Rani Lakshmi Bai Central Agricultural University, Jhansi (Uttar Pradesh) during *Rabi*, 2019-20 in Augmented Design in five blocks. Seeds of each genotype were sowed in a unit plot size of 3 meters long with a number of accession in each block is sixteen. Standard agronomic practices were followed for an enhanced crop of wheat and competitive crop stand. The observation was recorded on five randomly selected competitive plants from each genotype on fifteen agro-morphological and physiological characters *viz*; days to 50 percent heading, days to maturity, canopy temperature (^{o}C), chlorophyll content, flag leaf width (cm), flag leaf length (cm), tillers per meter, peduncle length (cm), plant height (cm), spike length (cm), awn length (cm), 1000-grain weight (g), grain yield per plant (g), biological yield per plant (g) and harvest index (%). The chlorophyll content is measured by SPAD-502 chlorophyll meter as well as canopy temperature was measured by using a handheld infrared thermometer. The analysis of variance for the quantitative character was carried out as per the standard statistical procedure for Augmented Randomized Complete Block Design (ARCBD) as given by Federer (1956). The genotypic and phenotypic coefficients of variation (GCV and PCV) were calculated by Burton and Dewane (1953) and Heritability in a broad sense was calculated by the variance component method, as a ratio of genetic variance to phenotypic variance and expressed in percentage. (Allard, 1960). The expected genetic advance resulting from the selection of five percent superior individual were worked out by Burton and

de Vane (1953) and Johnson *et al.*, (1955), and the phenotypic and genotypic correlation coefficient was worked out to determine using covariance techniques as Falconer (1960).

3. RESULT AND DISCUSSION

The analysis of variance for different characters is presented in Table 1. Analysis of variance was performed for all fifteen quantitative traits under study and results revealed that significant genetic differences were observed among the wheat genotypes for fourteen characters *viz;* for tillers per meter, plant height, peduncle length, day to 50 percent heading, thousand-grain weight, biological weight per plant, harvest index, days to maturity, grain yield per plant, awn length, spike length, and flag leaf width at 1 percent level of significance, and chlorophyll content, flag leaf length, at 5 percent level of significance, and canopy temperature were nonsignificant at both 5 and 1 percent level. Similar results were found to be corroborating with the findings of Meles *et al*. (2017), Bhanu *et al*. (2018), Mishra *et al*. (2019), and Tomar *et al*. (2019).

Table 1 Analysis of variance (ANOVA) for fifteen quantitative traits in wheat.

Source of variation	Blocks (adjusted)	Treatment (adjusted)	Check	Varieties	Check vs. Varieties	Error
Degree of freedom	4	81	2	78	1	8
Days to heading	10.66	41.76**	127.40**	42.42**	30.41*	3.56
Days to maturity	1.1	5.85**	10.86**	6.02**	4.76	0.95
Chlorophyll Content	5.73	13.66*	2.94	14.54**	8.71	2.82
Canopy Temperature	5.55*	2.63	2.37	2.52	0.13	0.94
Flag leaf width	0.02	0.07**	0.03	0.08**	0.26**	0.01
Flag leaf length	4.78	12.29*	56.89**	16.88**	3.28**	2.97
Tillers / meter	478.27	798.44**	2078.87**	763.49*	604	155.12

Peduncle length	0.84	45.63**	19.64**	52.91**	138.13**	2.04
Plant height	41.64**	171.69**	4.83	225.45**	292.35**	5.37
Spike length	0.84	2.10**	0.4	2.33**	0.66	0.23
Awn length	0.31	2.35**	1.70**	2.43**	0.01	0.08
1000 grain Weight	1.58	23.41**	56.14**	22.36**	74.80**	4.22
Biological yield	0.32	21.36**	13.82**	23.91**	153.96**	0.81
Grain yield	0.003	4.62**	3.38**	4.74**	42.07**	0.04
Harvest index	0.45	6.32**	0.76	6.76**	16.20**	0.73

**Significant at 5 per cent level; **Significant at 1 per cent level*

The estimates of range, mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (broad sense), and genetic advance are presented in Table 2. The highest GCV was recorded for tillers per plant (11.19) followed by awn length (8.49), peduncle length (7.66), and the highest PCV was recorded for tillers per meter (16.63) followed awn length (9.29), peduncle length (8.51), flag leaf length (8.16). The magnitude of PCV estimates was higher than the GCV estimates for all fifteen quantitative characters, indicating that the substantial influence of environmental variations is present in the performance of genotypes. The high estimates of GCV were also observed by Dabi *et al*. (2019) and Bhushan *et al*. (2013) for tillers per meter, Rajput (2018).

The range of heritability was observed from 26.30 percent for canopy temperature to 95.63 percent for grain yield per plant. Maximum values were observed for grain yield per plant (95.63 %), followed by plant height (86.10%), biological yield per plant (83.47%), awn length (83.45%), peduncle length (80.98 %), days to 50 percent heading (68.17%), spike length (61.00%) and harvest index (60.32%). The high estimate of heritability was also recorded by Abinasha *et al*. (2011), Kumar *et al*. (2017) and Rathwa *et al*. (2018) for plant height, Nukasami *et al*. (2013) for tillers per meter, 1000 grain weight, and plant height, Bhanu *et al*. (2018)

The maximum value (>20%) of genetic advance as a percent of mean and the moderates value (10-20 %) of genetic advance as a percent mean was reported for awn length (15.98%),

followed by tillers per meter (15.53%), peduncle length (14.20%), biological yield per plant (13.01%), plant height (12.83%) and grain yield per plant (10.19%). High estimates of genetic advance as percent of mean were also observed by Rathwa *et al*. (2018) for tillers per meter and number of grains yield per plant by Bhanu *et al*. (2018).

High heritability coupled with high genetic advance percent of mean was observed for grain yield per plant. High heritability combined with moderate genetic advance percent of mean was exhibited by biological yield per plant, plant height, peduncle length, and spike length. Low heritability and the low genetic advance percent of mean were observed for canopy temperature, days to maturity, and chlorophyll content.

The character association analysis for different characters is presented in Table 3. Days to 50 percent heading showed non-significant association with days to maturity (0.213), tiller per meter (0.181), biological yield per plant (0.171), grain yield per plant (0.169), spike length (0.058), harvest index (0.041), awn length (0.006), flag leaf width (0.002), 1000 grain weight (0.001), and canopy temperature (0.001), while, this trait had shown a significant negative association with plant height (-0.102) and canopy temperature (-.059), respectively. The number of tillers per meter exhibited a significant positive correlation with biological yield per plant (0.360**) followed by grain yield per plant (0.348**), days to maturity (0.259**), and plant height (0.254**). The Harvest index expressed a positive significant association with grain yield per plant (0.538**). Grain yield was positively correlated with different quantitative traits in the findings of Kumar *et al*. (2013) and Kumari *et al*. (2020) with biological yield, harvest index, and tillers per meter, Ayer *et al*. (2017) and Rajput (2018) with biological yield, harvest index and grains per spike and harvest index, Mecha *et al*. (2017) with number of spikelets per spike, 1000 grain weight and biomass yield.

Table 2 Details of genetic variability parameters for all the quantitative traits of wheat

S. No.	Character	Coefficient of Variation		Heritability (bs) %	Genetic advance	(GAM)
		PCV	GCV			
1	Days to 50% heading	4	3.302	68.17	4.7	5.62
2	Days to maturity	1.06	0.756	50.8	1.45	1.11

3	Chlorophyll content	4.904	3.232	43.43	2	4.39
4	Canopy temperature (°C)	5.032	2.58	26.3	0.61	2.73
5	Flag leaf width (cm)	7.248	5.388	55.27	0.17	8.25
6	Flag leaf length (cm)	8.169	5.068	38.49	1.74	6.48
7	Tillers per meter	16.631	11.199	45.34	15.73	15.53
8	Peduncle length (cm)	8.513	7.661	80.98	5.47	14.2
9	Plant height (cm)	7.234	6.713	86.1	11.02	12.83
10	Spike length (cm)	6.978	5.45	61	0.98	8.77
11	Awn length (cm)	9.296	8.492	83.45	1.27	15.98
12	1000 grain weight (g)	6.838	4.648	46.2	2.73	6.51
13	Biological yield (g)	5.926	5.414	83.47	3.82	10.19
14	Grain yield (g)	6.606	6.46	95.63	1.93	13.01
15	Harvest index (%)	3.441	2.672	60.32	1.69	4.28

Table 3 Simple correlation analysis between fifteen characters in wheat

	DH	DM	CL	CT	FW	FL	TM	PL	PH	SL	AL	TGW	GYPP	BYPP	HI
DH	1														
DM	0.213	1													
CC	-0.059	0.047	1												
CT	0.001	0.039	0.071	1											
FW	0.002	-0.015	0.119	-0.02	1										
FL	-0.300**	-0.074	-0.091	-0.06	0.255*	1									
TM	0.181	0.259*	-0.08	-0.118	-0.286**	-0.07	1								
PL	-0.306**	-0.026	-.309**	0.012	-0.168	0.458**	0.051	1							
PH	-0.102	0.047	-.290**	0.132	-0.304**	0.14	0.254*	0.758**	1						
SL	0.058	-0.095	0.07	0.298**	0.087	0.097	-0.280**	-0.057	-0.052	1					
AL	0.006	-0.125	-0.124	-0.046	0.172	0.093	-0.129	0.019	0.002	-0.06	1				
TGW	0.001	-0.328**	-0.15	0.011	0.239*	-0.031	-0.205	0.054	-0.009	0.226*	0.042	1			
GYPP	0.169	-0.03	-0.098	-.0243*	-0.051	-0.04	.348**	-0.067	0.085	-0.156	-0.214*	0.033	1		
BYPP	0.171	0.049	-0.142	-0.244*	-0.038	-0.067	0.360**	0.046	0.203	-0.111	-0.237*	0.048	0.890**	1	
HI	0.041	-0.17	0.069	-0.077	-0.028	0.025	0.081	-0.244*	-0.214*	-0.126	-0.042	-0.015	0.538**	0.097	1

DH-Days to 50% heading, DM-Days to maturity, CC-Chlorophyll content, CT-Canopy temperature, FW-Flaf leaf width, FL-Flag leaf length, TM- Tillers per meter, PL-Peduncle length, PH-Plant height, SL-Spike length, AL-Awn length, TGW-Thousand grain weight, GYPP-Grain yield per plant, BYPP-Biological yield per plant, HI-Harvest index.

**Significant at 5 per cent level; **Significant at 1 per cent level*

4. CONCLUSION

The study revealed that a wide range of variation was depicted for most of the characters. High PCV and GCV were exhibited for various characters. The narrow difference between PCV and GCV was recorded for the characters *viz.*, for grain yield per plant, biological yield per plant, days to maturity, spike length, and chlorophyll content suggesting that expression of these characters is less influenced by the environmental factors and strong inherent association among these traits is present. High heritability estimates were exhibited by grain yield per plant, suggesting that these characters are least affected by environment and selection is effective due to the additive effect of genotypic. The genetic advance as percent of mean was awn length, tillers per meter, peduncle length, biological yield per plant, plant height, and grain yield per plant which revealed the additive gene action. Grain yield per plant possessed a positive and significant correlation with biological yield per plant, harvest index, and tillers per meter suggesting that an increase in these component traits simultaneously improves economic grain yield per plant.

References

Abinasa M, Ayana A, Bultosa G. Genetic variability, heritability and trait associations in durum wheat (Triticum turgidum L. var. durum) genotypes. African Journal of Agricultural Research. 2011 Sep 5;6(17):3972-9.

Allard RW. Biometrical approach in plant breeding and genetics in plant breeding. Brook-haven Symposia in Biology. (1960); 9:69-88.

Ayer DK, Sharma A, Ojha BR, Paudel A, Dhakal K. Correlation and path coefficient analysis in advanced wheat genotypes. SAARC Journal of Agriculture. 2017 Jul 29;15(1):1-2.

Bhanu AN, Arun B, Mishra VK. Genetic variability, heritability and correlation study of physiological and yield traits in relation to heat tolerance in wheat (Triticum aestivum L.). Biomedical Journal of Scientific & Technical Research. 2018;2(1):2112-6.

Bhushan B, Gaurav SS, Kumar R, Pal R, Panday M, Kumar A, Bharti S, Nagar SS, Rahul VP. Genetic variability, heritability and genetic advance in bread wheat (Triticum aestivum L.). Environment & Ecology. 2013 Apr;31(2):405-7.

Burton, C. W., and E. H. De Vane. "Estimating heritability in tall Festuca (Restuca arundinacae)

from replicated clonal material." *Agron. J* 45 (1953): 1476-1481.

Dabi A, Mekbib F, Desalegn T. Genetic variability studies on bread wheat (Triticum aestivum L.) genotypes. Journal of Plant Breeding and Crop Science. 2019;11(2):41-54.

DAC&FW. Agricultural Statistics at a glance 2019. Department of Agriculture, Cooperation & Farmer Welfare. Government. 2020; 45-92.

Falconer DS. An introduction to quantitative genetics. *2nd edition, Longman, NewYork;* 1960.

Federer MT. Augmented design with one way elimination of heterogeneity. *Cornell University, Ithava, NewYork, USA*; 1961.

Islam MR, Faruquei MA, Bhuiyan MA, Biswas PS, Salam MA. Genetic diversity in irrigated rice. Pak. J. Biol. Sci. 2004;2:226-9.

Johanson HW, Robinson HF, Comstock RE. Genotypic and phenotypic correlations in soybean and their implication in selections. Agron. J. 1955;47:477-83.

Kumar B, Singh CM, Jaiswal KK. Genetic variability, association and diversity studies in bread wheat (Triticum aestivum L.). The Bioscan. 2013;8(1):143-7.

Kumar J, Kumar M, Kumar A, Singh SK, Singh L. Estimation of genetic variability and heritability in bread wheat under abiotic stress. Int. J. pure app. Biosci. 2017;5(1):156-63.

Kumari P, De N, Kumari AK. Genetic variability, correlation and path coefficient analysis for yield and quality traits in wheat (Triticum aestivum L.). Int J Curr Microbiol App Sci. 2020;9:826-32.

Mishra U, Sharma AK, Chauhan S. Genetic variability, heritability and genetic advance in bread wheat (Triticum aestivum L.). Int. J. Curr. Microbiol. App. Sci. 2019;8(7):2311-5.

Mecha B, Alamerew S, Assefa A, Assefa E, Dutamo D. Genetic Diversity Based on Multivariate analysis for Yield and it's Contributing Characters in Bread Wheat (Triticum aestivum L.) Genotypes. Agricultural Research & Technology. 2017;8(5):1-10.

Meles B, Mohammed W, Tsehaye Y. Genetic variability, correlation and path analysis of yield and grain quality traits in bread wheat (Tritium aestivum L.) genotypes at Axum, Northern Ethiopia. Journal of plant breeding and crop science. 2017 Oct 31;9(10):175-85.

Nukasani V, Potdukhe NR, Bharad S, Deshmukh S, Shinde SM. Genetic variability, correlation and path analysis in wheat. Journal of Cereal Research. 2013;5(2).

Rajput RS. Correlation, path analysis, heritability and genetic advance for morpho-physiological character on bread wheat (Triticum aestivum L.). Journal of Pharmacognosy and phytochemistry. 2018;7(2):107-12.

Rathwa HK, Pansuriya AG, Patel JB, Jalu RK. Genetic variability, heritability and genetic advance in durum wheat (Triticum durum Desf.). Int. J. Curr. Microbiol. App. Sci. 2018;7(1):1208-15.

Sharma P, Gujral HS. Anti-staling effects of β-glucan and barley flour in wheat flour chapatti. Food Chemistry. 2014 Feb 15;145:102-8.