



ESTIMATION OF GENETIC VARIABILITY, HERITABILITY AND CORRELATION FOR SOME QUANTITATIVE TRAITS IN WHEAT (*TRITICUM AESTIVUM* L.)

FMA Haydar^{1*}, MS Ahamed², AB Siddique¹, GM Uddin¹, KL Biswas¹ and MF Alam^{1&3}

¹Department of Botany, University of Rajshahi, Rajshahi-6205, Bangladesh

²Department of Food Science and Technology, Islamic University, Kushtia, Bangladesh

³Institute of Biological Sciences, University of Rajshahi, Rajshahi-6212, Bangladesh

Abstract

Seventeen genotypes of wheat were used in this study the results showed significant differences in respect of yield and other yield contributing characters. Highest phenotypic and genotypic coefficients of variations were observed in plant height and lowest values were observed in spike length in both cases. Heritability estimated was found to be high in case of grain yield/plant and this was followed by 100 grain weight. Significant positive correlation was found in plant height with number of fertile tillers/plant and grain yield/plant, fertile tillers/plant with spike length, spike length with grain yield and grain yield with 100 grain weight. Negative correlation was found in plant height with 100 grain weight. Plant height, fertile tillers/plant, spike length and 100 grain weight appeared to be the effective criteria for improvement of yield of wheat.

Key words: Correlation, Genetic variability, Heritability, Quantitative traits, Wheat

Introduction

Wheat (*Triticum aestivum* L.) is the most important grain and is being used as a staple food for more than one third of the world. Developing the varieties with high potential having desirable combination of characters is always the main objective of wheat breeding programme. The estimation of the genetic association and description of genetic variability between various genotypes are essential for breeders, because the artificial crosses between dissimilar parents permit a huge segregation and the grouping of various favorable alleles (Bered et al. 2002). Wheat is the second important staple food crop after rice in Bangladesh and the popularity of wheat is increasing day by day.

Wheat Research Centre (WRC) of Bangladesh Agricultural Research Institute (BARI) had already been released a good number of wheat varieties but the yield potentialities of these varieties are low as compared to wheat growing in developed countries (Ashfaq et al. 2014, Rahman et al. 2014). It has been recognized as the source of principal food of man for centuries. Wheat is the second important cereal crop after rice in Bangladesh. Wheat is a source of nutrition for 35% of the world population and currently ranks first among cultivated plants in terms of cultivation area and production. Wheat is used for both human and animal nutrition and plays an important role in the nutrition of rapidly growing populations both in our country and the world. In improving the food security of the world, wheat has played a significant role by contributing about 20 percent of the dietary calories and proteins. On an average 50% of the wheat in the world is produced in developing regions including Central Asia and China (Polat et al. 2016). Wheat becomes very popular in Bangladesh after the liberation war of Bangladesh in 1971 when it was realized that the country's

*Author for correspondence: aliarhaydar@yahoo.com

staple food rice alone was not sufficient to meet the food demand (Hossain et al. 2013). The annual mean growth rate was 24.93%. The cropping area rose from 0.126 million ha to 0.591 million hectares and production from 0.11 million tons to 1.07 million tons (Islam et al. 2016). At present about 429.61 thousand hectares of land in our country is covered by wheat with the annual production of 1302998 Mtons (BBS 2014). Yield is the function of many components which when modified has direct influence on the productivity (Mahboob et al. 2005). During the long association man has improved the yield and other agronomic characters of wheat plant by selection man have improved the yield and other agronomic characters of wheat plant by selection among the exaction genotypes. Modern plant breeding methods have accelerated the rate of improvement of wheat for yield and other agronomic characters. Grain yield in wheat is a complex phenomenon as it is polygenically controlled. For effective selection, information on nature and magnitude of variation in population, association of character with yield and among themselves and the extent of environmental influence on the expression of these characters are necessary.

In such situations, correlation and genetic variability analysis could be used as an important tool to bring information about appropriate cause and effects relationship between yield and some yield components. Correlation and genetic variability analysis leads us to a clear understanding of the genetic association of various plant traits and their contribution to yield.

Correlation analysis provides information about the correlated response plant characters to selection (Ahmad et al. 2003). The correlation co-efficient between yield and yield components generally demonstrate a compound sequence of interacting association. The objective of the present study was to estimate genetic variability, heritability and correlation of different characters in wheat on grain yield per plant which may be helpful to identify the genotype having potential for improving yield and its components.

Materials and Methods

The present investigations for correlation and genetic variability analysis studies of morphological traits of spring wheat were conducted in the experimental area of Plant Breeding and Genetic Engineering Lab., Department of Botany, University of Rajshahi, Rajshahi in 2016-2017. The experimental material consists of seventeen varieties of spring wheat i.e. Kalyansona, Protiva, Akbar, Sonora-64, Pavon-76, Sonalika, Triticale, Gourab, Ananda, Aghrani, Shourav, Kheri, Barkat, Kanchan, Inia, Seri-82 and Balaka. These genotypes were planted in the field according to a randomized complete block design with three replications. There were three lines per genotype in each replication. Seeds were sown with the help of dibbler maintaining row to row distance of 20 cm, plant to plant distance of 15 cm and the replication to replication distance of 120 cm. All other agronomic practices were kept uniform. At maturity ten plants per genotype from each replication were selected for recording of the data on the following characters: plant height (cm), number of fertile tillers/plant, spike length (cm), grain/spike, 100 grain weight (g) and grain yield/plant (g).

Statistical analysis

To determine the significance of data, the variance analysis for all the characters was carried out according to the technique given by Steel et al. (1997). The variance was partitioned into phenotypic and genotypic components. The heritability determination in broad sense was estimated as ratio between genotypic and phenotypic variance (Burton and Devan 1953). Correlation analysis was performed according to Kown and Torrie (1964). Genetic advance was calculated by percentage of mean as described by Brim et al. (1959).

Results and Discussion

Mean performances of different characters of the genotypes are shown in Table 1. Significant differences were found among the genotypes in respect of different characters. Highest grain yield/plant was obtained

from genotype Ananda (11.16 g) which was followed by genotype Kheri (10.25 g). Lowest yield was obtained from genotype Pavon-76 (5.09 g). Ananda gave the highest yield but it was statistically identical with other genotypes except Akbar, Sonora-64, Pavon-76 and Sonalika. Per plant grain yield gave the idea of 4.09 t/ha production in case of Anando followed by 3.30 t/ha in Kheri. Pavon-76 gave the lowest yield of 1.72 t/ha. The number of fertile tillers/plant ranged from (2.55 - 6.99). Kheri produced the highest number of tillers/plant and lowest number was statistically identical with others except Balaka and Inia. Highest plant height was obtained from the genotype Kheri (147.32 cm) and it was found in genotype Triticale (120.29 cm) and statistically identical with the rest except Balaka and Sonora-64. Hundred grain weight was highest in case of genotype Anando and statistically identical with five other genotypes Kalyan, Protiva, Aghrani and Shorav but non identical with the rest.

Table1. Mean performances of different characters of seventeen genotype of wheat

Genotypes	Plant height (cm)	No. of fertile tillers/plant	Spike length (cm)	Number of grain/spike	100 Grain weight (g)	Grain yield/plant (g)
Kalyansona	89.35	4.22	16.12	51.20	4.06	6.00
Protiva	100.00	5.66	15.66	47.50	4.15	7.29
Akbar	98.98	4.55	16.12	54.65	2.97	5.17
Sonora 64	94.63	4.22	15.00	51.25	3.02	5.11
Pavon-76	100.04	4.66	16.22	49.50	3.07	5.09
Sonalika	101.80	4.22	16.81	45.20	3.03	5.60
Triticale	120.29	6.99	18.60	57.50	3.78	9.87
Gourab	86.96	4.22	16.86	55.40	3.25	8.02
Anando	105.06	5.00	16.94	51.20	5.25	11.16
Aghrani	93.94	4.89	16.64	55.60	4.82	9.70
Shourav	99.10	4.44	16.69	55.60	4.19	8.67
Kheri	147.32	6.11	16.88	54.30	2.83	10.25
Barkat	99.86	5.11	17.15	55.70	3.89	7.54
Kanchan	98.25	4.11	16.67	53.20	4.29	7.10
Inia	94.43	3.66	16.59	49.60	3.26	7.05
Seri-82	92.91	5.22	15.90	54.35	3.61	7.60
Balaka	93.11	2.55	14.40	54.35	3.42	7.09
Mean	100.94	4.64	19.28	52.30	3.70	7.55

Highest value (191.82) for genotypic variance was observed by plant height followed by grain yield/plant while it remained low (0.36) for number of tillers/plant. High phenotypic variance was observed for plant height, grain yield/plant and number of fertile tillers respectively, while 100 grain weight showed lowest value (0.50) for this trait. The co-efficient of genotypic (GCV) and phenotypic variability (PCV) and heritability

(broad sense) were calculated by the method of components of variances followed by standard statistical method. Phenotypic and genotypic variance, genotypic and phenotypic coefficient of variation, heritability (Broad sense) and genetic advance expressed as percent of mean for the characters under study are presented in Table 2. Highest genotypic and phenotypic coefficient of variation was observed in case of plant height followed by grain yield per plant. Lowest value was observed in case of spike length. Values of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the traits under consideration. The results are agreed with Aharizad et al. (2012) who reported the similar results in wheat. In the present study, plant height, 100 grain yield and grain yield/plant showed high heritability coupled with moderate genetic advance as percentage of mean suggesting these three traits were controlled by both additive and non-additive genes and influenced by environment to a certain extent. Degewione et al. (2013) reported that days to heading exhibited high heritability with moderate genetic advance. These findings also confirmed by Hossain and Joarder (2006). High heritability with low genetic advance was reported by Salem et al. (2003). High heritability with low genetic advance as observed in flag leaf area and spike length indicating the non-additive gene effect.

Small differences existed between the value of genotypic and phenotypic variance for the characters were less influenced by the environment. Highest heritability estimated were observed in case of 100 grain weight followed by plant height which also indicated that these characters were also less influenced by the environments. Moderately high heritability values were found in case of characters of grain yield/plant and spike length. So high heritability of grain weight with moderate heritability of yielding capacity, the genotypes might tend to have more high yielding capacity.

Table 2. Estimated genetic parameters and mean sum of squares for different characters of wheat

Parameters	Plant height (cm)	No. of fertile tillers/plant	Spike length (cm)	Number of grain/spike	100 grain weight (g)	Grain yield/plant (g)
σ^2_p	206.45	2.36	1.15	3.54	0.50	4.18
σ^2_g	191.82	0.36	0.71	2.50	0.47	3.19
σ^2_e	14.63	2.01	0.44	1.04	0.03	0.99
GCV	190.03	7.56	4.34	7.15	12.81	42.37
PCV	204.52	50.97	7.01	9.20	13.42	55.43
ECV	14.5	43.41	2.68	2.05	0.61	13.06
Heritability(h^2_b)	92.91	14.84	61.82	61.00	95.51	76.44
GA (%) mean	27.25	10.13	8.32	22.25	37.50	42.70
MS (treatment)	590.09	3.07	2.58	5.80	1.44	10.58
MS (Error)	14.63	2.01	0.44	1.65	0.02	0.97

Correlation coefficient of yield and yield component are furnished in Table 3. The relationship among plant height with number of fertile tillers/plant was observed significant and spike length observed positive but non-significant. Degewione et al. (2013) and Khan et al. (2013) reported negative association with grain yield but Aruna and Raghavaiah (1997), Das et al. (1992) reported significant positive correlation of days to maturity with grain yield. These findings are in good in agreement with earlier results of Akbar et al. (1995), Nabi et al. (1998) and Chowdhry et al. (2000). On the other hand, negative correlation was observed between plant heights with 100 grain weight. Positive and highly significant correlation was observed between number of fertile tillers/plant and spike length. Number of fertile tillers/plant has showed positive but non-significant correlation with grain yield/plant and 100 grain weight. Spike length had positive and significant correlation with grain yield/plant and positive correlation but non-significant with 100 grain weight. A positive significant correlation was observed between grain yield/plant with 100-grain weight. These results are corroborated with the results of Gupta et al. (1999) and Singh and Singh (1999). It appeared from the study of correlation that plant height had maximum contribution to grain yield in wheat. Thus from the estimates of heritability, genotypic coefficient of variation and genetic advance in percentage of mean the plant height, number of fertile tillers/plant, spike length and 100 grain weight could be suggested as the effective criteria in breeding wheat for yield improvement.

Table 3. Correlation coefficients of yield components in wheat

Characters	No. of fertile tillers/plant	Spike length	Number of grain/spike	100 Grain weight	Grain yield/plant
Plant height	0.67**	0.43	0.49*	-0.19	0.49*
No. of fertile tillers/plant		0.63**	0.42	0.034	0.42
Spike length			0.52*	0.21	0.52*
Number of grain/spike				0.69*	0.65*
100 Grain weight					0.57*

*, ** = Significant at 5% and 1% level, respectively.

References

- Aharizad S, Mohsin S, Mohammadi SA and Khudadi E (2012). Multivariate analyses of genetic diversity in wheat (*Triticum aestivum* L.) recombinant inbred line using agronomic traits. *Annals of Biological Res.*, 3(5): 2118-2126.
- Ahmad MF, Mohammad K and Maqbool A (2003). Genetic variability and trait correlation in wheat. *Sarhad J. Agric.*, 19(3): 347-351.
- Akbar M, Khan NI and Chowdhry MH (1995). Variation and interrelationship between some biometric characters in wheat, *Triticum aestivum* L. *J. Aghri. Res.*, 33: 247-254.
- Aruna C and Raghavaiah P (1997). Correlations and path analysis of yield and quality in aestivum wheat (*Triticum aestivum* L.). *Journal of Research ANGRAU*, 25(4): 21-25.
- Ashfaq S, Hafiz MA, Shahid IA, Shehzad AK, Sarfraz M and Amjid MA (2014). Estimation of genetic variability, heritability and correlation for some morphological traits in spring wheat. *Journal of Biology, Agriculture and Healthcare*, 4(5): 10-16.
- BBS (2014). Bangladesh Bureau of Statistics. Estimates of wheat, 2014. Government of the Peoples Republic of Bangladesh. Agriculture Wing. Dhaka. p. 1-2.

- Bered F, Barbosa J and Carvalho F (2002). Genetic variability in common wheat germplasm on coefficient of percentage. *Genetics and Mol. Biol.*, 25(2): 211-215.
- Brim CA, Johnson HW and Cockerham CC (1959). Multiple selection criteria in wheat. *Crop Sci.*, 1: 187-190.
- Burton GW and Devan EH (1953). Estimating heritability in tall fescue (*Festuca ruandinacea*) from replicated clonal material. *Argon. J.*, 45: 478-481.
- Chowdhry MA, Ali M, Subhani GM and Khaliq I (2000). Path coefficient analysis for water use efficiency, evapotranspiration efficiency, transpiration efficiency, transpiration efficient analysis for water use efficiency and some yield related traits in wheat. *Pak. J. Bio. Sci.*, 3: 313-317.
- Das RK, Islam MA, Howlader M, Ibrahim SM, Ahmed HU and Miah NM (1992). Variability and genetic association in upland rice. *Bangladesh. J. Pl. Breed. Genet.*, 5: 51-56.
- Dash PK (2002). Genetic variability, heritability and path analysis in some selected F7 lines of wheat. MS thesis. Bangladesh. Agri. Univ., Mymensingh.
- Degewione A, Dejene T and Sharif M (2013). Genetic variability and traits association in bread wheat (*Triticum aestivum* L.) genotypes. *Int. Res. J. Agri. Sci.*, 1(2): 19-29.
- Gupta AK, Mittal RK and Ziauddin A (1999). Association and factor analysis in spring wheat. *Ann. Res.*, 20: 481-485.
- Hossain A and Teixeira JADS (2013). Wheat production in Bangladesh: its future in the light of global warming. *AoB Plants*, vol. 5, pls042; doi:10.1093/aobpla/pls042.
- Hossain MS and Joarder OI (2006). Genetic variability, correlation and path analysis in some quantitative traits in wheat. *Bangladesh J. Crop Sci.* 17: 1-6.
- Islam MS, Halder T, Hossain J, Mahmud F and Rahman J (2015). Genotype-environment interaction in spring wheat (*Triticum aestivum* L.) of Bangladesh. *Bangladesh J. Pl. Breed. Genet.*, 28(2): 17-24
- Khan AA, Alam MA, Alam MK and Alam MJ (2013). Genotypic and phenotypic correlation and path analysis in durum wheat (*Triticum turgidum* L. var. durum). *Bangladesh J. Agril. Res.*, 38(2): 219-225.
- Kown SH and Torrie JH (1964). Heritability and inter-relationship among traits of two soyabean populations. *Crop Sci.*, 4: 196-8.
- Mahboob AS, Arain MA, Shamadad KMH, Umar MD and Nisar AN (2005). Yield and quality parameters of wheat genotypes as affected by sowing dates and high temperature stress. *Pak. J. Bot.*, 37(3): 575-584.
- Nabi TG, Chowdhry MA, Aziz K and Bhutta WM (1998). Interrelationship among some polygenic traits in hexaploid spring wheat (*T. aestivum* L.). *Pak. J. Bio. Sci.*, 1: 299-302.
- Polat POK, Cifci EA and Yagd A (2016). Stability performance of bread wheat (*Triticum aestivum* L.) lines. *J. Agr. Sci. Tech.*, 18: 553-560.
- Rahman MS, Hossain MS, Islam MS, Shoma JF and Ali L (2014). Genetic variability correlation and path analysis for some quantitative traits in wheat. *Ecofriendly Agri. J.*, 7(12): 158-162.
- Salem I, Khan AS and Ali A (2003). Estimation of heritability and genetic advance for grain yield traits in wheat (*Triticum aestivum* L.). *J. Anim. Pl. Sci.*, 13(1): 52-54.
- Singh KH and Singh TB (1999). Character association regarding generations of bread wheat. *Agri. Sci. Digest (Karnal)* 19: 207-210.
- Steel RDG, Torrie JH and Deekey DA (1997). Principles and procedures of statistics. A Biometrical Approach. 3rd Ed. McGraw Hill, Inc. Book Co., New York. pp. 352-358.

(Manuscript received on September 05, 2019 and revised on October 29, 2019)