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Study on genetic divergence and relationship between yield and yield contributing characters in spring wheat

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Abstract: The present research work was aimed at to study the genetic divergence and relationship between yield and yield contributing characters in 20 genotypes of spring wheat. The characters viz.days to 90% maturity, plant height, spikes per plant, spike length, grains per spike, 100 grain weight, harvest index and grain yield per plant were investigated and significant variations were observed among the genotypes. Divergence analysis clustered the studied genotypes into 4 diverse groups. The maximum number of genotypes were included in cluster II followed by Cluster I. The cluster III and IV contained few numbers of genotypes. The highest intra-cluster distance was obtained for cluster II followed by Cluster I and cluster III. The maximum inter-cluster distance was observed between genotypes of cluster III and IV followed by cluster II and III, and cluster III and I. Comparison of cluster means for all the characters indicated considerable genetic divergence between the groups. Study of correlations showed that grain yield per plant was significantly and positively correlated with grains per spike at both phenotypic and genotypic levels and with spikes per plant at phenotypic level. Among the studied characters, spikes per plant showed the highest phenotypic coefficient of variation followed by grain yield per plant, grains per spike, harvest index and 100-grain weight. Study of heritability indicated that the characters plant height, 100-grain weight, days to 90% maturity and spikes per plant were highly heritable. Path coefficient analysis also confirmed that grains per spike, 100-grain weight, plant height and spikes per plant influenced grain yield directly in positive direction. Among them, grains per spike contributed the maximum effect on grain yield per plant. So, these characters should be taken into consideration in selection for yield improvement.
Key words: Genetic divergence, spring wheat, heritability, correlation and path coefficient

Introduction

Spring wheat (*Triticum aestivum* L.) is one of the most important cereal crops in the world. It ranks first in acreage as well as production among the crops of the world (FAO, 2000). It is second most important cereal in Bangladesh next to rice (BARI, 1982). Currently, total cropped land area of Bangladesh is 14.22 million hectares of which wheat covers an area of 706882 hectares (BBS, 2005). Total wheat production was 1607000 tons of food grain with an average yield of 2.13 tons per hectare in the year 2004-2005 (BBS, 2005). In order to elevate the average production of this cereal in Bangladesh, it is necessary to strengthen the breeding work on scientific basis; study of genetic diversity of the parents used in hybridization programme is an important factor in this direction. But it is difficult to measure such diversity in the population. However, Mahalanobis's D2 statistics appears to be a good index to measure the inherent genetic distance existing among the genotypes in a population (Mahalanobis, 1936). For planning yield improvement program, the knowledge of relationship between yield and yield contributing characters are important. Information on correlation coefficients between yield and yield contributing characters has always been helpful as a basis for selection for yield in a breeding program. Therefore, correlations between yield and different yield contributing characters are an aspect, which should be kept in mind for planning yield improvement program. Path coefficient which is a standardized partial regression coefficient (Wright, 1921) specifies the causes and effects and measures the relative importance of each variable. So, correlations in combination with path coefficient analysis are an important tool to find out the association and quantify the direct and indirect influences of yield contributing characters on grain yield. For such reasons relation between yield and yield contributing characters have been studied through genotypic and phenotypic correlations and the path coefficient analysis by many authors in spring wheat (Das and Mondal, 1984; Uddin, 1975).

Materials and Methods

The study was conducted in the field laboratory of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh during the period from November 2008 to March 2009. Twenty genotypes of spring wheat were collected from wheat germplasm collection of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University. The experiment was set up in a Randomized Complete Block Design (RCBD) with three replications. The plot size was 2.5m × 1.5m with 50 cm distance consecutive plots as well as between two blocks. The spacing between rows and that of between plants in a row was 25 cm and 5 cm, respectively. Observations were recorded on ten plants randomly selected in each genotype in each replication on days to 90% maturity, plant height, spikes per plant, length of spike, grains per spike, 100 grain weight, biological yield, grain yield per plant, harvest index. Mahalanobis's D2 statistics was used to calculate the genetic divergence in the present population. The genotypes were grouped into different clusters according to the method described by Tocher's (Rao, 1952) and (Singh and Chaudhury, 1985).

Results and discussion

Genetic divergence between the genotypes: The genetic diversity among the genotypes were studied through estimating Mahalanobis's D2-statistics.Using Mahalanobis's D2 statistics and Tocher's method, the genotypes were grouped into 4 distinct clusters. The maximum number (10) of genotypes were included in the cluster II followed by Cluster I (7). The clusters III and IV contained small number of genotypes, 2 and 1 respectively. Comparison of intra and inter cluster distance indicate that the genotypes belonging to the same cluster had smaller D^2-values than between those belonging to different clusters (Table 1).

Table 2 shows that inter cluster distance are always higher than that of intra cluster distance. It indicated wider diversity among the genotypes of different clusters. The intra-cluster distances in all the four clusters were low indicating the close relationship of the genotypes within the same cluster. The highest intra-cluster distance was obtained for cluster II followed by Cluster I and cluster III. The maximum inter cluster distance was observed between genotypes of cluster III and IV followed by cluster II and III and cluster III and I. Therefore, hybridization among genotypes drawn from these widely divergent clusters with high yield potential would likely to produce heterotic combinations and wide variability in segregation generations.

Table 1. Distribution of 20 spring wheat genotypes in different clusters

Cluster	No. of total genotypes in cluster	Name of genotypes in the cluster
I	7	TP-2, BAW-898, KPL-1-40, Ning-8317, SA-7, Soughat, BAW-456
II	10	Agrani, BAW-1027, Kalaysona, SA-2, BAW-960, DSN-33, FYN-PVN, Wuhan, Chyria-3, DSN-76
III	2	Ananda, Seri 82
IV	1	Kheri

Table 2. Average intra and inter-cluster distance (D =√D2) for 20 spring wheat genotypes

Characters	I	II	III	IV
I	20.52	26.12	62.15	34.4
II		25.31	71.23	41.17
III			15.1	76.09
IV				0

Table 3. Cluster mean values for yield and yield contributing characters in spring wheat

Characters	Cluster			
	I	II	III	IV
Days to 90% maturity (days)	110.16	113.25	124.8	125.3
Plant height (cm)	69.06	70.62	78.64	98.43
Spikes per plant (no.)	4.11	4.16	5.08	9.07
Spike length (cm)	8.64	8.38	9.71	9.03
Grains per spike (no.)	28.52	35.23	37.04	33.47
100 grain weight (g)	2.88	3.22	2.88	2.38
Harvest Index (%)	24.98	30.38	18.78	15.79
Grain yield per plant (g)	2.41	3.54	3.07	3.83

Cluster mean for yield and different yield contributing characters are presented in Table 3. It appears that the dwarf and early maturing genotypes were included in the cluster I. The genotypes included in the cluster IV produced maximum number of spikes per plant which was followed by the genotypes of the cluster III. Genotypes having long spike were included in cluster III followed by cluster IV. The genotype of cluster III produced maximum number of grains per spike. The genotype of cluster II produced highest harvest index. Lowest harvest index found in the genotype of cluster IV. Considering grain yield per plant, it was observed that the genotype of the cluster IV produced the highest grain yield per plant. This was followed by the genotypes of cluster II. The genotype in the cluster I produced comparatively lower yield per plant.

Relationship between yield and yield contributing characters: Relationship between grain yield and different yield contributing characters in spring wheat were studied through genotypic and phenotypic correlation coefficients. The causes of such relations were further analyzed through path coefficient.

Correlation coefficients: The genotypic and phenotypic correlation coefficients between yield and different contributing characters of 20 spring wheat are presented in the Table 4. The magnitudes of genotypic correlation coefficients were generally higher than their corresponding phenotypic correlation coefficients. This suggests that there were strong inherent relationship between the traits but the environmental correlation between them acted in opposite direction and reduced the phenotypic correlation coefficients. In many cases, the

differences between genotypic and phenotypic correlation coefficients were higher, suggesting importance of environmental effects on relationship between them at phenotypic level.
From the table, it appears that grain yield per plant was positively and significantly correlated with grains per spike at both phenotypic and genotypic levels and with spikes per plant at phenotypic level. This suggests that grain yield per plant would increase with the increase of these characters.

Table 4. Genotypic (r_g) and phenotypic (r_p) correlation coefficients between yield and yield contributing characters

Characters		Plant height (g)	Spikes/ plant	Spike length (cm)	Grains/ spike	100-grain weight (g)	Harvest index (%)	Grain yield per plant (g)
Maturity	r_g	0.671**	0.618**	0.297	0.498*	-0.222	-0.616	0.423
(days)	r_p	0.609**	0.562**	0.203	0.353	-0.235	-0.393	0.390
Plant height	r_g		0.873**	0.485*	0.079	-0.067	-0.669	0.429
(cm)	r_p		0.772**	0.418	0.117	-0.074	-0.534	0.383
Spikes/ plant	r_g			0.356	0.186	-0.390	-0.676	0.388
	r_p			0.291	0.245	-0.372	-0.505	0.474**
Spike length	r_g				0.242	-0.266	-0.533	-0.086
(cm)	r_p				0.223	-0.202	-0.429	-0.027
Grains/ spike	r_g					-0.498	0.062	0.542
	r_p					-0.429	0.076	0.594*
100-grain	r_g						0.318	0.152
weight(g)	r_p						0.236	0.067
Harvest index	r_g							0.191
(%)	r_p							0.238

* and ** indicates significant at 5% and 1% level of probability respectively

Table 5. Path coefficients of different yield and yield contributing characters on grain yield per plant in spring wheat

Characters	Days to 90% maturity (days)	Plant height (cm)	Spikes/ plant (cm)	Spike length (cm)	Grains spike	100 grain weight (g)	Harvest index (%)	Total correlation to grain yield/ plant (g)
Maturity	-0.287	0.349	0.280	-0.106	0.461	-0.131	-0.143	0.423
Plant height	-0.192	0.521	0.396	-0.173	0.0731	-0.039	-0.156	0.429
Spikes/plant	-0.177	0.455	0.454	-0.127	0.172	-0.231	-0.157	0.388
Spike length	-0.085	0.252	0.161	-0.357	0.224	-0.157	-0.124	-0.086
Grain/spike	-0.143	0.041	0.084	-0.086	0.926	-0.295	-0.014	0.542
100-grain weight	0.063	-0.034	-0.177	-0.095	-.461	0.592	0.074	0.152
Harvest index	0.177	0.348	-0.307	0.190	0.057	0.188	0.233	0.191

(Residual effect, R = 0.23) The bold and diagonal figures are the direct effects and those off-diagonals are indirect effects on grain.

Path coefficient analysis: Yield is a complex character influenced by many components or contributing traits both in positive and negative directions. The complex relationship between yield and its contributing characters is simplified by analysis of path coefficients. The path coefficient analysis was performed using genotypic correlation to determine direct and indirect influences of different yield contributing characters on grain yield and it was presented in the Table 5.
From the table, it appears that grains per spike, 100-grain weight, plant height and spikes per plant contributed to grain yield directly in positive direction. Among them grains per spike contributed the maximum effect on grain yield per plant. The genotypic correlation of grains per spike with grain yield was also high and significant. The

character plant height and spikes per plant had also considerable high positive and direct effect on grain yield per plant. The correlation coefficient of these characters with grain yield per plant was high. In addition, plant height influenced grain yield indirectly via spikes per plant. Again, spikes per plant influenced grain yield indirectly via plant height.

This information and results of the present study indicate that grains per spike, 100-grain weight, plant height, and spikes per plant were the most important characters that contributed directly to grain yield per plant. Out of them, grains per spike, 100-grain weight and spikes per plant are the primary yield components and plant height is one of the important morphological traits contributing to grain yield in spring wheat. Therefore, selection for these characters would give better response to grain yield improvement in spring wheat.

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