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Estimation of Some Genetic Parameters and Inter-Relationship of Grain Yield and Yield Related Attributes in Certain Exotic Lines of Wheat (*Triticum aestivum* L.)

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Abstract
To estimates the heritability, genetic advance and interrelationship of yield and yield related attribute in certain exotic lines of wheat introduced from ICARDA (International Center for Agriculture Research in Dry Areas), a field experiment was carried out in the research area of Plant Breeding and Genetic, PMAS, University of Arid Agricultural Rawalpindi during 2010-11. The research materials comprised of twenty three wheat genotypes including a local check variety (Chakwal 97) were planted in randomized completed block design with three replications. Data were recorded and analyzed on plant height, days to maturity, No. of tillers m^{-2}, spike length, 1000 grain weight, and grain yield Kg/ha. The genotypes were highly significant for all the traits except for days to maturity where non significantly difference was observed. Maximum broad sense heritability was observed for grain yield per plot (93.34) while minimum value (7.82) was recorded for days to maturity. Value of genetic advance range from minimum 0.23 for days to maturity to maximum (589.49) for grain yield (Kg/ha) was assessed. Genotypic correlation coefficient was observed greater in magnitude has compared to phonotypic correlation coefficient in maximum character pairs. Phonotypic and genotypic correlation coefficient of grain yield with No. spikelets/spike, days to maturity, No. of tillers/m^2 and No. of grains/spike was observed positive and significant whereas plant height and spike length was found has deterrent traits for grain yield improvement because these characters showed negative association with grain yield.
Keywords: Heritability, Genetic Advance, Phenotypic Correlation, Genotypic Correlation, Wheat

Introduction

Wheat is the most important cereal crop extensively grown all over the world. In Pakistan, wheat is the major food grain and being staple diet of the peoples, it occupies a central position in national economy. Wheat contributes 10.1% to the value added in agriculture and 2.2% to the GDP. Area under wheat crop during the year 2012-13 was 8693 thousand hectare with an estimated production of 24231 thousand tones (GOP, 2012-13). Through concerted research efforts, a number of varieties have been developed which enhanced the national wheat production significantly, however due to low average yield as compared to other advanced countries, plant breeders are interested to further boost the productivity. This demand an understanding and constant vigilance on genetic makeup of the wheat plant. Genetic variability is the basis of selection and further improvement in any crop species. Broader the range of heritable variation more effective will be the selection and vice versa. Wide range of variability makes it convenient to select a particular trait with ease and efficacy (Firouzian, 2003).

Study of statistical parameters like variance, Phenotypic Coefficient of Variation, Genotypic Coefficient of Variation, Environmental Coefficient of Variation, heritability and genetic advance is not only helpful to evaluate the genetic stability and performance of any particular genotype but it is also a measure to determine the effectiveness of selection for a particular trait in that genotype. High genetic advance coupled with high heritability estimates offer the most affective condition for Selection (Larik *et al*., 1989). Therefore, a good knowledge of heritability and genetic advance existing in different yield parameters is pre-requisite for improvement in wheat. (Khan *et al.,* 2003) estimated broad sense heritability in wheat for some morphological characters and revealed that plant height, number of tillers per plant, peduncle length and grain yield showed higher magnitude of broad sense heritability and genetic advance. From a study regarding genetic parameters in wheat (Ashraf *et al*, 2002) reported moderate heritability for Spike length and 1000 grain weight in 16 wheat varieties. Patil and Jain (2002) studied the nature and magnitude of variation of yield and yield components and observed high heritability for all traits except spikelet per spike and number of grains per spike.

In addition, characters association among all these attributes contributing to forward yield is necessary to understand. Analysis of correlation coefficient offers an opportunity to get an idea about causal relationship between the two characters. (Shahid *et al.,* 2002) observed that grain yield had significant positive genotypic correlation with spike length, grains per spike and grain weight per spike while plant height showed strongly negative genotypic correlation with grain yield. He further observed significant and Positive phenotypic

correlation of No. of tillers par m^2 with grains per spike, grain weight per spike. (Khaliq *et al.,* 2004) ascertained characters association in wheat genotypes and reported that grain yield showed positive and significant correlation with plant height, tillers per m^2, spike length, spikelets per spike and 1000 grain weight. Mondal and Kuljeet (2004) determined genotypic and phonotypic correlation for certain traits and revealed that grain yield per plant was positively and significantly correlated with number of tillers per m^2. In present study, 23 wheat genotypes introduced for ICARDA (International Center for Agriculture Research in Dry Areas) along with local check (Chakwal 97) were evaluated, to estimates the genetic variability, index of transmissibility, genetic advance and to ascertain the association among yield and its components.

Materials and Methods

The experiment was laid out in the research area of Department of Plant Breeding and Genetics, PMAS, University of Arid Agriculture, Rawalpindi during 2010-11. The research material comprised of 23 wheat breeding lines of ICARDA (International Center for Agriculture Research in Dry Areas) along with one local check (Chakwal-97). These genotypes were planted in a three row plot following randomized complete block design with three replications. The row length was kept as 4m whereas row to row and plant to plant spacing was kept as 30cm and 20cm respectively. All plant protection measures and cultural practices were adopted according to the requirement of the crop. Ten guarded plants from each replication were selected randomly and data were recorded on following parameters: Plant Height in cm (PH), Number of Tillers per m^2 (TP), Spike Length in cm (SL), Number of Spikelets per Spike (SS), No. of Grains per Spike (GS), 1000 Grain Weight in gram (TGW). However data for Days to maturity (DM), and Grain Yield per Plot in gram (GHP) were recorded on plot basis (4m x 1.2 m). Then grain yield was converted into Kg/ha. The data were subjected to analysis of variance by performing MSTAT software. The heritability and genetic advance were measured by following (Singh and Chaoudhry, 1979).

$$\text{Heritability in Broad sense } (h^2) = Vg/Vp$$

Where Vg is the genotypic variance and Vp is the phenotypic variance.

Genotypic, phenotypic and environmental coefficients of variation were calculated by using formula as under;

$$\text{Genotypic Coefficient of Variation (CVg)} = \sqrt{Vg}/\text{Mean of X} \times 100$$

$$\text{Phenotypic Coefficient of Variation (CVp)} = \sqrt{Vp}/\text{Mean of X} \times 100$$

$$\text{Environmental Coefficient of Variation (CVe)} = \sqrt{Ve}/Mean\ of\ \text{X} \times 100$$

Where X is the grand mean of the particular attribute

Genetic advance was calculated by formula following Singh and Chaudhary (1979).

$$\text{Genetic Advance (G.A)} = K.\ h2.\sqrt{Vp}$$

Where K is Constant = 2.05 at 5% selection intensity.

Correlation co-efficient analysis (Phenotypic and genotypic) were calculated according to the method given as Kwon and Torrie (1964).

Results and Discussions

The result of analysis of variance showed that all the traits under studied were highly significant except for days to maturity indicating the presence of sufficient variability for effective selection to identify potential genotypes (Table-1). The estimates of genotypic, phenotypic and environmental variance, genotypic, phenotypic and environmental coefficient of variation, heritability and genetic advance are presented in table-3. The genotypic coefficient of variation for the entire attributes examined was less than the phenotypic coefficient of variation. This result indicated that role of environment is prominent in the expression of these traits. The high genotypic and phenotypic coefficient of variations were found for No. of tillers per m^2 and grain yield Kg ha^{-1}. Relative amount of heritable portion of variation can be assessed through estimation of h^2 (Broad Sense Heritability) is the only useful genetic parameter for predicting direct and corrected response: (Dudley & Moll, 1969). However, sometime high heritability is not indication of high genetic advance. It is therefore suggested by various researchers (Ajmal et al., 2009; Khaliq *et al*., 2009; Khan & Naqvi, 2011) that high magnitude of h^2 should be combined with genetic advance in the prediction of phenotypic expression of trait them h^2 alone. In the present investigation, high heritability with high genetic advance was obtained for No. of tillers/m^2 and Grain yield Kg/ha. This result revealed that, high estimates of h^2 and genetic advance for these traits would be helpful for the plant breeders to select for the best combination and to reach at the desirable level of yield potential in wheat. These results are in accordance with finding of (Khaliq *et al*., 2009; Khan & Naqvi, 2011and Mondal & Kuljeet, 2004). They also found high heritability coupled with high genetic advance for these traits. However moderate broad sense heritability couple with low genetic advance was found in 1000 grain weight. Moderate broad sense heritability estimates suggest that selection should be delay to more advance generation for this trait.

Present results are confirmed with the finding of, (Humaira *et al*., 2004; Ajmal *et al*., 2009; Khan & Naqvi, 2011). They reported moderate heritability with low genetic advance for this character. All the others parameter in the studied show low heritability with low genetic advance it means that care must be taken for these characters and in future this can be used only after passing through intensive selection criterion. These results can are also supported by (Larik *et al*., 1999; Gupta & Verma, 2000; Hasan *et al*., 2004; Patil & Jain, 2002).

Table-1 Name/ Parentage and Pedigree of Exotic Wheat Lines from ICARDA

S. No.	Name/Parentage	Pedigree
1	MEXIPAK 65	118156-0PAK
2	KAUZ//ALTAR 84/AOS	CM1116333-6M-020T-010Y-010M-2Y-0M-0AP
3	KAUZ//GYS//KAUZ	CMBW90M4837-0T0PU-11M-2Y-010M-010Y-5M-015Y-0Y-0Y-0AP
4	KAUZ//PFAU/VEE/5	CMBW90Y292-12Y-010M-010M-010Y-8M-015Y-0Y-0AP
5	ANGRO/2*BCN	CMBW90Y3215-0T0PM-010M-010M-010Y-8M-015Y-0Y-0AP
6	ATTILA/3*CAZO	CMBW90Y4399-0T0PM-1Y-010M-010M-010Y-8M-015Y-0Y-0AP
7	NESTRO/3/HEI/3*CNO79//2*SERI	CMSS92M00092S-015M-0Y-0Y-050M-25Y-2M-0Y-0AP
8	CHAM	CM39816-IS-1AP-0AP
9	BR39/3/F60314.76/MRL//CNO79	CMSS93MO1092S-38Y-010M-3Y-1M-0Y-0AP
10	KATILA-3	CMSS93Y00066S-2AP-1AP-3AP-0APS-0AP
11	KATILA-11	CMSS93Y00066S-5AP-2AP-2AP-0APS-0AP
12	WH576/PASTOR	CMSS93Y00147S-3AP-1AP-4AP-0APS-0AP
13	OASIS/SKZUZ//4*BCN	CMSS93Y0404M-0Y-0AP
14	HAAMA-11	ICW93-0014-1AP-0BR-5AP-2AP-7AP-0APS-0AP
15	GOUMRIA-14	ICW94-0029-0L-6AP-3AP-2AP-0APS-0AP
16	CHAM-6	CM39992-8M-7Y-0M-0AP
17	NAAMA-4	ICW94-0052-0L-2AP-1AP-7AP-0APS-0AP
18	NAAMA-6	ICW94-0052-0L-2AP-2AP-2AP-0APS-0AP
19	NAAMA-9	ICW94-0052-0L-2AP-2AP-7AP-0APS-0AP
20	ZERBA-5	ICW94-0061-0L-1AP-1AP-8AP-0APS-0AP
21	RAAD-6	ICW94-0146-0L-4AP-4AP-0APS-0AP
22	AMAARA-2	ICW94-0257-0L-1AP-2AP-8AP-0APS-0AP
23	GIRWILL-3	ICW94-0383-0L-5AP-1AP-3AP-0APS-0AP
24	CHAKWAL-97	LOCAL CHECK

Table-2 Mean Squares for various plant attributes in some exotic lines of wheat during 2010-11

Source of Variation	Plant Height	Days to Maturity	No. of Tillers m^{-2}	Spike Length	No. of Spikelets $Spike^{-1}$	No. of Grains $Spike^{-1}$	1000-Grain Weight	Grain Yield (Kg/ha)
Genotype	47.644**	1.376	21814.55**	2.637**	5.143**	29.455**	0.653**	272091.06**
Replication	10.773	2.097	1533.824	1.493	1.062	8.295	0.121	1912.847
Error	15.113	1.894	1229.841	1.375	1.222	14.518	0.092	6322.268

**Significant at 1 % Level

Table-3 Estimates of Genotypic, Phenotypic & Environmental Variance, Genotypic Coefficient of Variance, Phenotypic Coefficient of Variance & Environmental Coefficient of Variance, Heritability and genetic Advance.

Genetic Parameters	Plant Height	Days to Maturity	No. of Tillers m^{-2}	Spike Length	No. of Spikelets $Spike^{-1}$	No. of Grains $Spike^{-1}$	1000-Grain Weight	Grain Yield (Kg/ha)
Vg	10.84	0.16	6861.57	0.42	1.31	4.98	0.19	88589.60
Ve	15.11	1.89	1229.84	1.38	1.22	14.52	0.09	6322.27
Vp	25.96	2.05	8091.41	1.80	2.53	19.50	0.28	94911.87
CVg	2.15	0.42	486.40	0.14	5.07	3.04	1.15	20.89
CVe	180.98	329.51	7.21	858.77	21.79	125.29	26.39	380.68
CVp	3.32	1.49	528.20	0.28	7.06	6.02	1.40	21.62
h^2	41.78	7.82	84.80	23.43	51.68	25.54	67.03	93.34
G.A	4.36	0.23	156.37	0.64	1.68	2.31	0.73	589.49

* Genotypic Variance (Vg), Phenotypic Variance (Vp) Environmental Variance (Ve), Genotypic Coefficient of Variance (CVg), Phenotypic Coefficient of Variance (CVp), Environmental Coefficient of Variance (CVe), Heritability in Broad Sense(h^2)and genetic Advance (G.A)

Grain yield is a quantitative character and influenced by environment. It is multiplicative end product of numerous genetically controlled traits which singly or jointly influence it. Therefore good knowledge of association of these characters is vital importance for selection of high yielding genotypes. The genotypic and phenotypic correlations are presented in Table-4 and Table-5 respectively. From the results of present study, both in genotypic and phenotypic correlation grain yield significantly and positively correlated with days to maturity, No. of tillers/m^2, No. of spikelets per spike and No. grains/spike. These results are in confirmatory with the results of (Baseer *et al.,* 2000; Lad *et al*., 2003; Mondal & Kuljeet 2004; Ajmal *et al*., 2009). On the other hand, grain yield had negative and non significant correlated with spike length at genotypic and phenotypic level as well with value of (-0.104) and (-0.193) respectively. Buttha and Chudhary (1999) and (Hasan *et al.,* 2004) also implicated negative and non significant association between these traits. Number of tillers/m^2 showed significant and positive relationship with spike length and No. of grains /spike at genotypic level and significant and positive with spike length at phenotypic level. Some early researcher (Baseer *et al*., 2000; Ahmad *et al*., 2003; Khan *et al*., 2003) also reported same results. Spike length exhibit positive and significant relationship with number of spikelets per spike at phenotypic level whereas it showed negative correlation with 1000 grain weight at both genotypic and phenotypic levels. Similar trends for these traits were also observed by (Ali *et al.,* 2008; Leghari *et al*., 2010). A positive and significant relationship was demonstrated between No. of spikelets per spike and No. of grains per spike and 1000 grain weight both at genotypic and phenotypic levels. These results are in corroborated with the findings of Lad *et al*., 2003; Okuyauma *et al.,* 2004; Ali *et al*., 2008; Leghari *et al.,* 2010). The comparison of the correlation coefficient showed that estimates of genotypic correlation coefficient are generally of higher magnitude then those of phenotypic correlation coefficient. This revealed that association among these traits was largely under the genetic controlled.

Conclusion

From the results of present investigation, it is concluded that grain yield can be enhanced by improving yield related attributes (Days to Maturity, No. of Tillers m^{-2}, No. of Spikelets $Spike^{-1}$ and No. of Grains $Spike^{-1}$). The grain yield had significant and positive association with these traits. The information investigated by this research will be helpful for the plant breeders to select the high yielding superior genotypes which possessed these specific attributes.

Table-4 Genotypic Correlation Coefficient among various plant attributes in some exotic Wheat genotypes during 2010-11

Parameters	Days to Maturity	No. of Tillers m^{-2}	Spike Length	No. of Spikelets $Spike^{-1}$	No. of Grains $Spike^{-1}$	1000- Grain Weight	Grain Yield (Kg/ha)
Plant Height	0.403*	0.141	-0.627**	0.429*	0.418*	0.452*	0.213
Days to Maturity		-0.583**	-0.581**	0.832**	0.225	0.167	0.596*
No. of Tillers m^{-2}			0.481**	-0.471*	0.443*	-0.113	0.491*
Spike Length				0.230	0.105	-0.154	-0.114
No. of Spikelets $Spike^{-1}$					0.459*	0.435*	0.581**
No. of Grains $Spike^{-1}$						0.135	0.491*
1000- Grain Weight							0.119

* and ** Significant at 5% and 1% respectively

Table-5 Phenotypic Correlation Coefficient among various plant attributes in some exotic Wheat genotypes during 2010-11

Parameters	Days to Maturity	Plant Height	No. of Tillers m^{-2}	Spike Length	No. of Spikelets $Spike^{-1}$	No. of Grains $Spike^{-1}$	1000- Grain Weight
Plant Height	0.434*						
No. of Tillers m^{-2}	-0.473*	0.137					
Spike Length	0.437*	-0.440*	0.491*				
No. of Spikelets $Spike^{-1}$	0.693**	0.495*	-0.459*	0.411*			
No. of Grains $Spike^{-1}$	0.428*	0.236	0.290	-0.201	0.432*		
1000- Grain Weight	0.123	0.407*	-0.174	-0.147	0.394	0.107	
Grain Yield (Kg/ha)	0.447*	-0.209	0.573**	-0.193	0.596**	0.409	0.101*

* and ** Significant at 5% and 1% respectively

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