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Research Article

Correlation and Heritability Studies of Yield and Yield Related Traits in F5 *Triticum aestivum* Lines from a Cross Cv Fsd-08 × Cv S-24

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Abstract

The heritability estimates give information about traits which are transferred from one generation to another generation, and it has important role in selection criteria to enhance the yield potential. The purpose of current study was to estimate heritability and genetic advance of F_5 wheat lines derived from a cross of Faisalabad 2008 and S-24. Eight yield parameters were evaluated during the year 2019-20 in complete randomize design with five replicates. The results of ANOVA showed significant difference (P ≤0.001) in all studied traits. High broad sense heritability was observed for grain yield per spike (82.49%) followed by tillers per plant (81.77%) and spikelet per spike (76.65%). Moderate to low genetic advance was observed for all the traits except plant height (79.47%), and grain yield per spike have 73.10%. Grain yield have positive correlation with fertile tiller, 100 seed weight and grain yield per spike. The traits grain yield per spike, tillers per plant and spikelet per spike deserve more attention in future breeding programs for evolving better wheat yield.

Key words: Broad sense heritability, GCV, Genetic advance, PCV, Wheat

1. Introduction

Wheat (*Triticum aestivum* L.) is a major cereal crop all over the world as major contributor to human diet and rich in energy so called king of cereals. It provides 36 percent food and shares 20 percent food calories to the population throughout world (Tabinda and Bharadwaj, 2015). Generally, Asia is the principal contributor in wheat production and produce approximately 40 percent of overall wheat production that is near about 292.5 million tones as compared to the global production that is approximately 653.6 million tones. In Asia, China is major contributor of the wheat that produces approximately 115.5 million tones followed by India and Pakistan (Gianessi, 2014). On the other hand, average hectare^{-1} wheat production in Pakistan is very low as comparison to other countries (Fao, 2008). The FCA (Federal Committee on Agriculture) fixed wheat production target at 28.9 million tons, expecting a sowing area of 9.2 million hectares for the Rabi season 2021 to 22, an increase of 1.4 million tons over last year's production (DAWN, October 8, 2021).

For a successful plant breeding program, the genetic variations present in breeding material used in the program has primary importance. The observed difference is combination of genetic and environmental factors. The successful selection depends on genetic divergence, heritability estimates and association of agro-morphological traits with grain production. The estimates of heritability along with correlation studies offer a better consideration of the association of important traits with grain yield (Ali *et al.*, 2008).

The improvement of crop relies on genetics during various breeding programs. The Higher ratio of Ve (environmental variance) lower will be the chance to choose the genetic variations. Similarly, the selection rate will rise when ration of difference due to environmental factors is lower than genetic variability (Ali *et al.*, 2017). Therefore it is suggested to be appropriate knowledge about heritability and selection reply for essential yield linked traits during crop enhancement programs (Waqar-Ul-Haq *et al.*, 2008). The traits having high heritability could be choose during breeding programs that will make easier progress to those traits having low heritability estimates (Shahid *et al.*, 2002).

Grain yield is the most important polygenetic trait in cereal crops which is not only affected by external environment but also depends upon other yield related traits. Therefore, our selection should not be directly based upon grain yield, but focus should also be given to other yield related traits. Besides the knowledge of Grain yield is the most important polygenetic trait in cereal crops which is not only affected by external environment but also depends upon other yield related traits. Therefore, our selection should not be directly based upon grain yield, but focus should also be given to other yield related traits (Akhtar and Chowdhary, 2006; Majumder *et al.*, 2008, Kumar *et al.* 2019).

Present study was conducted to explore genetic variability, heritability and correlation among wheat advanced lines using eight yield related traits to devise selection criteria for isolation of best performing lines.

2. Materials and Methods

The data was recorded for the year 2019-2020. The seeds of F_5 progeny and their parent varieties Faisalabad 2008 and S-24 were obtained to conduct the research. The experiment was carried out in complete randomized block design having 5 replicates. The distance between lines were kept 12 cm. The recommended dose of nitrogen and phosphorus were used before and after sowing the crop. Weeds were removed manually as and when required.

At maturity 5 plants were selected at random from each line in each replication for recording data on six quantitative traits including plant height, number of productive tillers per plant, number of spikelets per spike, spike length, number of grains per spike, 100 grain weight (g) and yield per plant (g).

The mean data was subjected to analysis of variance to test the level of significance among the parent genotypes and F_5 progeny (Steel and Torrie, 1980).

The broad sense heritability was calculated as a ratio of genotypic to phenotypic variance. The expected genetic advances estimated. The genotypic and phenotypic coefficients of variations were calculated for the estimation of variability (Falconer, 1996).

$$h^2B = Vg / Vp$$

where,

Vg = genotypic variance

Vp = phenotypic variance

$$\text{Genetic Advance (GA)} = K \times (Vp)^{0.5} \times h^2B$$

where,

K = selection intensity at 5% (2.06)

Vp = phenotypic variance

h^2B = heritability (broad sense)

$$GA\ (\%) = GA / GAM \times 100$$

GA=Genetic advance

GAM=Genetic advance Mean

Phenotypic Coefficient of Variation (PCV) =

Phenotypic Variance (Vp) / Mean value of the trait × 100

Genotypic Coefficient of Variation (GCV) =

Genotypic Variance (Vg) / Mean value of the trait × 100

3. Results and Discussion

Plant height is one of the important characters that determine the yield along with other characters. The short stature of wheat plants was responsible for the green revolution. Short stature plants are desirable in wheat to obtain more yield per acre. Higher plants generally considered as a source of substantial amount of straw which has not much importance. The mean square depicts highly significant variation among the genotypes for plant height (Table 1). The mean value for plant height (cm) of wheat from 63.55 to 94.80 cm (Table 2). The phenotypic coefficient of variance and genotypic coefficient of variance for plant height was 9.33% and 5.56% respectively. The broad-sense heritability percentage for plant height was 35.57% and the genetic advance percentage was 79.47% (Table 3). In the present data, low heritability with high genetic advance was observed. The broad sense heritability for plant height is 35.57% which means this trait is less heritable than other traits. Jocković *et al.* (2013) observed low heritability estimates in *Helianthus annuus* L. Kamboj (2003), Sial (2007), Khan and Naqvi (2011) who reported high heritability and low genetic advance for plant height for wheat.

Table 1. Mean square values for plant height, spike length, spikelet spike^{-1}, total tillers, fertile tillers, total seed weight, 100 seed weight, yield spike^{-1} of F5 wheat lines.

SOV	df	Plant Height (cm)	Spike Length (cm)	Spikelet per spike	Tillers per Plant
Lines	103	460.146***	5.639***	22.322***	12.00***
Error	416	27.4681	1.007	2.553	3.890
SOV	**df**	**Fertile Tillers**	**Total Seed Weight**	**100 Seed Weight**	**Total Yield Spike^{-1}**
Lines	103	15.427***	48.915***	1.339***	0.472***
Error	416	6.1173	12.658	0.752	0.246
Total	519				

***=Highly significant at 0.001 level

Table 2. Estimation of heritability and genetic advance (%) for yield and yield related traits in F5 lines of wheat.

Parameters	Mean	Min.	Max.	PCV%	GCV%	H^2b%	GA%
Plant Height	79.47	63.55	94.80	9.33	5.56	35.57	79.47
Spike Length	10.94	9.30	13.18	11.51	4.62	7.29	10.94
Spikelet/Spike	20.11	14.23	24.34	10.71	9.38	76.65	20.12
Total Tillers	7.25	4.4	11.5	20	18.09	81.77	10.75
Fertile Tillers	10.76	6.2	13.4	35.43	20.18	32.43	7.25
Total Seed Weight (g)	9.81	4.31	20.26	35.03	17.17	24.01	9.81
100 Seed Weight (g)	4.06	3.06	5.19	15.39	7.85	25.97	33.48
Yield/Spike(g)	0.98	0.50	2.27	43.84	39.81	82.49	73.10

Table 3. Phenotypic correlation coefficients of yield and yield related traits

Traits	PH	SL	SS	TPP	FTP	GYP	HSW	GYS¹
PH	1							
SL	0.4073***	1						
SS	0.3685***	0.1252**	1					
TPP	0.2602***	0.1947***	0.0137^{ns}	1				
FTP	0.1129**	0.1063*	0.0053^{ns}	0.5056***	1			
GYP¹	0.0468^{ns}	-0.0035^{ns}	0.1199**	-0.0137^{ns}	0.0699^{ns}	1		
HSW	-0.1007*	0.0123^{ns}	-0.0345^{ns}	0.0457^{ns}	0.1754***	0.1561***	1	
GYS¹	0.1558***	0.0691^{ns}	0.1097*	0.0302^{ns}	0.0568^{ns}	0.3587***	0.1102*	1

PH: Plant height; **SL**: Spike length; **SS**: Spikelet spike; **TPP**: Tillers per plant; **FTP**: Fertile tiller per plant; **GYP**: Grain per plant; **GYP**: Grain yield per plant; **HSW**: Hundred seed weight; **GPS**: Grains per spike; ns = non-significant; *, **, *** = 0.05, 0.01, 0.001 levels respectively.

Spike length is another important trait, as large spikes are likely to produce more grains which lead to more yield per plant. Higher phenotypic coefficient of variability compared to genotypic is indicative of more environmental influence. Mean square analysis of variance showed significant difference for spike length (Table I). The mean value for spike length (cm) of wheat ranges from 9.30 to 13.18 cm, respectively. The phenotypic coefficient of variance and genotypic coefficient of variance for spike length (cm) was 11.51% and 4.62% respectively. The broad-sense heritability percentage for spike length was calculated 7.2% and the genetic advance percentage was 10.94% (Table II). In our data, the heritability estimates were observed low along with low genetic advance as observed by Nabi *et al.* (1998) and Jedynski (2001) in their experiments among some polygenic traits in hexaploid (6n) spring wheat. Moderate heritability with low genetic advance has been reported for spike length by (M *et al.*, 2004).

The spikelet per spike is an important yield enhancing trait because increased spikelets will increase number of grains and eventually grain yield will be increased. Also found same lower values of (PCV) and (GCV) in number of spikelets per spike. The mean square analysis of variance showed significant difference for spikelets per spike (Table I). The mean value for Spikelet per spike of wheat ranges from 14.23 to 24.34. The phenotypic coefficient of variance and genotypic coefficient of variance for spikelet spike^{-1} was 10.71% and 9.38% respectively. The broad-sense heritability percentage for spikelet spike^{-1} was 76.65% and the genetic advance mean was 20.12% (Table II). The broad sense heritability of spikelet per spike is high which means this trait is more heritable. High heritability along with moderate value of genetic advance was also reported by (Ali *et al.*, 2008; Mahmood and Chowdhry, 2000; Sharma and Garg, 2002) in wheat for spikelet per spike which are like our result.

Number of tillers per plant is a yield related trait, as it is directly related with number of spikes plant^{-1}. Thus, greater number of tillers per plant will ensure greater grain yield (Firouzian *et al.*, 2003). Mean square analysis of variance for tillers per plant showed significant difference (Table I). The mean value for total tillers of wheat ranges from 4.4 to 11.5. The phenotypic coefficient of variance and genotypic coefficient of variance for the total number of tillers was 20% and 18.09% respectively. The broad-sense heritability for the total number of tillers was calculated 81.77% and the genetic advance mean value is 10.75% (Table II). The broad sense heritability of tillers per plant is high which means this trait is more heritable. Addisu and Shumet (2015) observed similar results in Barley (*Hordeum vulgare* L.). High heritability and low genetic advance for tillers per plant and grains per spike is seen in the present data but Ajmal *et al.* (2009) observed high heritability and moderate genetic advance in wheat. Sardana *et al.* (2007) suggested that high heritability may not necessarily lead to increased genetic gain unless sufficient genetic variability existed in the germplasm.

The mean square analysis of variance showed significant difference for fertile tillers. Mean value for fertile tillers of wheat ranges from 6.2 to 13.4. Maximum numbers of fertile tillers were recoded 13.4 and a minimum of 6.2. The phenotypic coefficient of variance and genotypic coefficient of variance for fertile tillers were 35.43% and 20.18% respectively. The broad-sense heritability for fertile tillers was calculated 32.43% and the genetic advance value in percentage is 7.25% (Table II). For fertile tillers, low broad sense heritability estimate along with moderate genetic advance was observed, indicating that it is controlled by non-additive gene action. The broad sense heritability of fertile tillers is 32.43% which means this trait is less heritable. Assefa *et al.* (2000) observed 23% heritability estimates for tillers per plant.

Grain yield per plant is a character of chief importance and of special interest to a wheat breeder. Higher estimates for heritability, genetic gain and variability would be important to a wheat breeder to choose promising cross combinations and to attain the maximum level of yield potential. Mean square analysis of variance showed significant difference for grain yield per plant. The mean value for grain yield per plant ranges from 4.31 g to 20.26 g. The phenotypic coefficient of variance and genotypic coefficient of variance for total seed weight were 35.03% and 17.17% respectively. The broad sense heritability in percentage is calculated 24.01% and genetic advance mean percentage value was calculated 9.81% (Table II). Kahrizi *et al.* (2010) reported low heritability estimates for grain yield. Ijaz *et al.* (2013) reported high heritability and genetic advance for number of tillers per plant and grain yield per plant.

Hundred seed weight is another principal component of grain yield in wheat. Genotypes showed highly significant difference for hundred seed weight. The mean value for 100 seed weight (g) of weight ranges from 3.06 to 5.19 g. The phenotypic coefficient of variance and genotypic coefficient of variance for total seed weight was 15.39% and 7.85% respectively. Broad sense heritability percentage for 100 seed weight is calculated 25.97 and the genetic advance in percentage was 33.48% (Table II). High broad sense heritability along with moderate genetic advance was reported by (Farshadfar *et al*., 2013).

Grain yield per spike is a major component of yield and have significant contribution to grain yield. Highly significant differences were observed from mean square analysis of variance for all genotypes (Table I). The mean value for the total yield/spike (g) of wheat ranges from 0.50 g to 2.27 g. The phenotypic coefficient of variance and genotypic coefficient of variance values for total seed weight was 43.84% and 39.81% respectively. Broad sense heritability for total yield/spike (g) was estimated 82.49 and the genetic advance percentage was 73.10% (Table II). For grain yield per spike other researchers also reported high heritability estimates like (Baloch *et al*., 2016; Kumar *et al*., 2012).

The phenotypic correlation of different parameters is shown in the (Table III). The yield and related traits express different trend of relationship among themselves.

There is a positively and significantly association between plant height, spike length (0.4073), Spikelet per spike (0.3685), tiller per plant (0.1129), fertile tiller per plant (0.1129), grain yield per spike (0.1558), and a negative association was found with hundred seed weight (-0.1007). Grain yield per spike was non significantly associated with plant height (0.1558). Similarly, spike length was found positively and significantly associated with spikelet per spike (0.1252), tillers per plant (0.1947), fertile tiller per plant (0.1063). There is non-significant association of spike length was present between grain yield per spike (-0.0035), hundred seed weight (0.0123), and grain yield per spike (0.0691).

Spikelet per spike was found significantly correlated with grain yield per plant (0.1199), and grain yield per spike (0.1097), but a non-significant association was found with tillers per plant (0.0137) fertile tillers per plant (0.0053), and hundred seed weight (0.0345). Tillers per plant was found significantly correlated with fertile tillers per plant (0.5056). Grain yield per plant (-0.0137), hundred seed weight (0.0457) and grain yield per spike (0.0302) was found non significantly associated to tillers per plant. Fertile tillers per plant was found significantly associated with grain yield per plant (0.0699), hundred seed weight (0.1754), and non-significant correlation with grain yield per spike (0.0568). Grain yield per plant was found associated with hundred seed weight (0.1561) and grain yield per spike (0.3587). Hundred seed weight was found significantly correlated with grain yield per spike (0.1102). Positive association of yield grains per spike and 1000-grain weight was observed by (Iftikhar *et al*., 2013). Positive correlation between 1000 grain weight and plant height in barely was observed by (Hadjichristodoulou, 1990). These findings were reported by (Efisue *et al*., 2014) in rice (*Oryza sativa* L.). The number of fertile tillers are positively and non-significantly correlated with total yield per plant. Ali *et al*. (2008) observed a positive association between grain yield and productive tillers per plant in wheat.

4. Conclusion

The results of the study showed that for all the traits the genotypes differed significantly. Heritability values were observed high for all the traits while genetic advance was observed low to moderate, which is an indicator that non-additive gene action was controlling the expressions of these characters. So, selection is suggested to be delayed to later segregating generations. Furthermore, phenotypic correlation revealed positive correlation of grain yield with plant height, spikelet per spike, and fertile tillers suggesting that more importance should be given to these traits for improving the yield in wheat.

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Author's contribution

Conceptualization of research (SA, HRA); Designing of the experiments (SA, HRA, ZUZ); Contribution of experimental materials (SA, SSQ, AT); Execution of field/lab experiments and data collection (SA, MJ, ZUZ, MA, SSQ, AT); Analysis of data and interpretation (SA, HRA, MA); Preparation of the manuscript (SA, MJ, HRA).

Declaration

The authors declare no conflict of interest.

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