Heritability Analysis for Yield Associated Traits in Wheat (*Triticum aestivum* L.)

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Abstract: The present study was conducted in the experimental area, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. F₂ population of ten cross combinations, namely: Wn-81 x SH-95, Wn-81 x Faisalabad-08, Wn-82 x SH-95, Wn-82 x Faisalabad-08, Wn-86 x SH-95, Wn-86 x Faisalabad-08, Wn-86 x Lasani-08, Miraj-08 x SH-95, Miraj-08 x Faisalabad-08 and Miraj-08 x Lasani-08, involving seven wheat varieties/lines, was studied to determine the broad-sense heritability and genetic advance for plant height, days to heading, days to maturity, number of tillers per plant, peduncle length, grain weight per spike and grain yield per plant. High heritability and genetic advance for plant height, peduncle length, days to heading, days to maturity, number of tillers per plant and grain yield per plant was given by Miraj-08 x Sh-95, Wn-86 x Faisalabad-08, Wn-81 x Faisalabad-08, Wn-81 x Sh-95 and Miraj-08 x Lasani-08. The cross combinations Miraj-08 x SH-95, Miraj-08 x Lasani-08, Wn-81 x Sh-95 and parent genotypes must be given due consideration in breeding programme for the improvement of yield related traits.

Key words: Heritability, genetic advance, grain yield, peduncle length

INTRODUCTION

Bread wheat is the staple food of masses in most countries of the world. It is most widely grown cereal crop of Pakistan. Wheat contributes 2.2% to GDP and 10.1% value addition in agriculture (GOP., 2013). In order to cope with increasing demand of wheat we need high yielding wheat genotypes adapted to changing environmental conditions. The production of wheat can be increased either by increasing area or by increasing production per unit area. We have limited area so only choice left is to increase the production potential of the crop (Tahir *et al.*, 2008). The success of any breeding programme depends on the presence of genetic variability in existing germplasm. Therefore understanding the genetic architecture of crop helps plant breeder to predict behaviour in succeeding generations. Study of inheritance for yield and associated traits is the subject of intensive studies for wheat breeders. Grain yield is complex character affected by various other traits and environmental factors therefore direct selection for grain yield is not suitable. An effective selection depends on the presence of genetic variability. High heritability alone is not sufficient for selection in advance generations. It must be accompanied by the substantial amount of genetic advance (Memon *et al.*, 2007). High heritability and genetic advance for plant height, tillers per plant and grains per spike have been reported by the Khan and Chowdhry (1979). Similarly Awaad (1996) reported high

heritability for grain yield and 1000 grain weight. High genetic parameters for yield associated traits such as for plant height, tillers per plant, grains per plant, 1000-grain weight by Ahmed *et al.* (2007). High heritability coupled with high genetic advance for plant height, peduncle length, days to heading and grain yield was reported by Ijaz *et al.* (2013). High genetic parameters for plant height, spike length and grain yield was also reported by Kisana *et al.* (1982). This study was aimed to identify F₂ segregates with high values of genetic parameters for yield and related traits. The present research work was designed to determine grain yield contributing characters, genetic variability for these characters, assessment of genetic parameters, such as heritability and genetic advance and selection of parental genotypes as well as F₂ hybrids for further breeding programme on the basis of their performance in each cross.

MATERIALS AND METHODS

The proposed study was carried out in the experimental area of Plant Breeding and Genetics, University of Agriculture, Faisalabad, during November 2010. The seeds of F₂ populations involving 7 varieties/lines of bread wheat as their parents, viz. WN-81, WN-82, WN-86, SH-95, Faisalabad-08, Lasani-08 and Miraj-08. The seeds of parent genotypes were obtained from Wheat Research Institute, Ayub Agriculture Research Institute, Faisalabad.

The lines were planted in a randomized complete block design with three replications for the estimation of heritability and genetic advance. Plant-to-plant and row-to-row distance was kept as 15 and 30 cm, respectively. Two seeds per hole were sown with the help of dibble and later thinned to one seedling per hole after germination. The experimental populations were kept under normal conditions from sowing to maturity. Necessary precautions were taken to avoid the contamination of genetic material. The crosses were as under:

Miraj-08 x SH-95, Miraj-08 x Faisalabad-08, Miraj-08 x Lasani-08, Wn-81 x SH-95, Wn-81 x Faisalabad-08, Wn-82 x SH-95, Wn-82 x Faisalabad-08, Wn-86 x SH-95, Wn-86 x Faisalabad-08 and Wn-86 x Lasani-08.

At maturity 200 plants from F_2 generation of each cross and 20 plants from each parent were taken and data were recorded. The data were recorded for Plant height, Days to heading, Days to maturity, Number of tillers per plant, Peduncle length and Grain yield per plant. However, days to heading were measured, when 50% heading was completed in each entry/genotypes. Heritability estimates in broad sense (h^2) expressed in percentage were computed, using the formula as described by Mahmud and Kramer (1951).

$$h^2 = \frac{VF_2 - \sqrt{VP_1 \times VP_2}}{VF_2} \times 100$$

Where:

h^2 = Heritability

VF_2 = Variance of F_2 population

VP_1 = Variance of parent 1

VP_2 = Variance of parent 2

Genetic Advance (GA) was calculated using the following Allard (1960) formula:

$$G.A = \sigma \text{ of } F_2 \times h^2 \times I$$

Where:

σ = Standard deviation of F_2

h^2 = Broad sense heritability in fraction

I = Constant value that reflect the selection intensity

The value used for I in this study at 10% selection pressure, was 1.755.

RESULTS AND DISCUSSIONS

Plant height: Mean, variances and coefficient of variability values for plant height are shown in Table 1(a).

The highest average plant height among parents was given by Wn-82 (107.58 cm) followed by Wn-86 (105.68 cm) and the lowest mean value was obtained for Faisalabad-08 (93.62 cm). Plants with small height are less vulnerable to lodging and enhances grain yield. Among F_2 cross combinations Miraj-08 x SH-95 (98.13 cm) have the highest mean plant height which is greater than parental mean values on the other hand cross combination the lowest mean plant height was obtained for Miraj-08 x Faisalabad-08, i.e. 88.91 cm, which is lower than parental mean values. Maximum variation for plant height exists in Miraj-08 x SH-95 as indicated by the highest values of variance and C.V%, i.e. 115.53 and 10.95, respectively. Table 2 depicted that for plant height, heritability estimates in broad sense ranged from 18.40-83.57%. While the value of genetic advance ranged from 1.70-15.76 for plant height. The highest value of heritability (83.57%) was found in cross Miraj-08 x SH-95 having the value of genetic advance (15.76). While the lowest heritability estimates 18.40% was observed in cross Wn-82 x Faisalabad-08, associated with genetic advance of 1.70. High values for genetic parameters indicate that plant height can be improved through selection. Similar findings were also reported by Khan and Chowdhry (1979), Ferdous *et al.* (2010) and Ijaz *et al.* (2013).

Days to heading: Table 1 indicates mean, variances and Coefficient of variability values for Days to heading. The mean and variances for F_2 ranged from 82.93-89.40 and 2.90-10.35, respectively. The C.V% ranged from 2.06-3.74 obtained for cross combinations Wn-86 x SH-95 and Wn-81 x SH-95. Heritability estimates in broad sense days to heading ranged from 3.94-85.14%. While the values of genetic advance ranged from 0.15-4.10. The highest value of heritability (85.14%) was given by cross Wn-86 x Faisalabad-08 having the value of genetic advance (4.10). While the lowest heritability estimates 3.94% was observed in the cross Miraj-08 x Lasani-08, coupled with genetic advance of 0.15. These genetic parameters indicate the existence of sufficient amount of variability which is heritable. Therefore improvement in this trait can be made through selection (Ijaz *et al.*, 2013).

Days to maturity: Among F_2 cross combinations Wn-81 x Faisalabad-08 on average requires maximum days for maturity, i.e., 120 while minimum average days for maturity were taken by Wn-86 x SH-95, i.e., 114. The highest value for C.V% was shown by cross Wn-82 x Faisalabad-08 and, the lowest value was obtained for Wn-86 x Faisalabad-08, i.e., 13.55 and 2.69, respectively. These values indicate the presence of variation for days to

Table 1(a): Mean ($\bar{x}$), Variance (δ^2) and coefficient of variability (CV) of plant height, days to heading and days to maturity

Genotypes	Plant height (cm)			Days to heading			Days to maturity		
	$\bar{x}$	δ^2	CV	$\bar{x}$	δ^2	CV	$\bar{x}$	δ^2	CV
Parents									
Wn-81	97.98	19.30	4.48	86.60	6.80	3.01	119.40	1.30	0.95
SH-95	93.66	18.93	4.65	82.20	1.70	1.59	115.20	6.70	2.25
Faisalabad-08	93.62	13.67	3.95	89.00	2.50	1.78	119.80	3.70	1.61
Wn-82	107.58	37.34	5.68	85.00	2.50	1.86	117.40	4.30	1.77
kWn-86	105.68	30.59	5.23	83.00	4.11	2.29	119.60	1.80	1.12
Lasani-08	93.74	22.94	22.94	89.20	5.70	2.68	118.80	5.70	2.01
Miraj-08	97.06	19.02	4.49	86.20	3.70	2.23	116.00	9.89	2.71
F₂ populations									
Wn-81 x SH-95	97.58	46.81	7.01	85.93	10.35	3.74	117.27	8.64	2.51
Wn-81 x Faisalabad-08	94.31	54.11	7.80	89.40	4.69	2.42	117.47	7.70	2.36
Wn-82 x SH-95	94.26	73.25	9.08	86.13	7.41	3.16	117.00	9.00	2.56
Wn-82 x Faisalabad-08	97.05	27.69	5.42	88.60	4.11	2.29	120.13	13.55	3.06
Wn-86 x SH-95	97.25	43.12	6.75	82.93	2.92	2.06	114.73	4.07	1.76
Wn-86 x Faisalabad-08	94.63	31.99	5.98	87.33	7.52	3.14	119.40	2.69	1.37
Wn-86 x Lasani-08	94.39	43.28	6.97	88.47	7.84	3.16	118.80	3.74	1.63
Miraj-2008 x SH-95	98.13	115.53	10.95	83.07	4.50	2.55	115.67	4.32	2.52
Miraj-08 x Faisalabad-08	88.91	73.51	9.64	89.00	4.86	2.48	117.67	5.67	2.02
Miraj-08 x Lasani-08	93.43	30.63	5.92	85.27	4.78	2.56	118.73	4.92	1.87

Table 1(b): Mean ($\bar{x}$), variance (δ^2) and coefficient of variability (CV) of number of tillers, peduncle length and grain yield per plant

Genotypes/characters	No. of tillers per plant			Peduncle length			Grain yield per plant		
	$\bar{x}$	δ^2	CV	$\bar{x}$	δ^2	CV	$\bar{x}$	δ^2	CV
Parents									
Wn-81	14.00	26.00	36.42	23.62	3.45	7.86	25.70	31.49	21.84
SH-95	8.60	2.30	17.63	27.60	10.07	11.50	18.30	6.68	14.12
Faisalabad-08	9.60	11.30	35.02	25.70	1.88	5.34	14.42	11.99	24.01
Wn-82	14.00	23.50	34.63	25.66	9.84	12.23	21.98	10.60	14.81
Wn-86	13.60	30.80	40.81	26.16	6.64	9.85	24.42	25.58	20.71
Lasani-08	9.20	2.20	16.12	26.56	7.25	10.14	13.08	2.34	11.70
Miraj-08	16.80	32.20	33.78	31.66	7.60	8.71	24.86	10.01	12.73
F₂ populations									
Wn-81 x SH-95	11.20	36.17	53.70	27.11	7.86	10.35	15.17	56.82	49.68
Wn-81 x Faisalabad-08	10.07	21.92	46.51	26.09	4.71	8.32	12.61	22.48	37.61
Wn-82 x SH-95	8.87	17.55	47.25	25.25	12.74	14.14	12.22	30.05	44.86
Wn-82 x Faisalabad-08	10.67	20.95	42.91	24.63	5.27	9.32	11.57	20.49	39.14
Wn-86 x SH-95	10.93	22.50	43.38	28.48	11.02	11.66	13.82	15.97	28.92
Wn-86 x Faisalabad-08	10.40	19.97	42.97	27.24	3.83	7.19	7.35	67.18	47.23
Wn-86 x Lasani-08	12.13	12.55	29.20	24.97	8.51	11.68	17.30	31.98	32.69
Miraj-2008 x SH-95	11.00	9.29	27.70	31.16	55.28	23.86	13.67	16.77	29.95
Miraj-08 x Faisalabad-08	11.33	41.24	56.66	25.49	7.03	10.40	12.51	30.59	44.22
Miraj-08 x Lasani-08	9.87	10.70	33.15	30.05	8.85	9.90	15.01	41.36	42.84

Table 2: Heritability and Genetic Advance of plant height, days to heading, days to maturity, number of tillers per plant, peduncle length and grain yield per plant

Genotypes/characters	Plant height		Days to heading		Days to maturity		No. of tillers per plant		Peduncle length		Grain yield per plant	
	$h^{2\%}$	G.A	$h^{2\%}$	G.A	$h^{2\%}$	G.A	$h^{2\%}$	G.A	$h^{2\%}$	G.A	$h^{2\%}$	G.A
F₂ populations												
Wn-81 x SH-95	59.17	7.10	67.16	3.79	65.83	3.40	78.62	8.3	25.06	1.23	74.47	9.85
Wn-81 x Faisalabad-08	69.98	9.03	12.01	0.46	71.50	3.48	21.82	1.79	45.99	1.75	13.54	1.13
Wn-82 x SH-95	63.71	9.57	72.18	3.45	40.36	2.13	58.11	4.27	21.82	1.37	72.00	6.93
Wn-82 x Faisalabad-08	18.40	1.70	39.24	1.40	70.57	4.56	22.23	1.79	18.36	0.74	44.99	3.57
Wn-86 x SH-95	44.19	5.08	68.47	2.05	14.60	0.52	62.58	5.21	25.82	1.50	18.15	1.27
Wn-86 x Faisalabad-08	36.07	3.58	85.14	4.10	3.91	0.11	6.59	0.52	7.79	0.27	73.93	10.63
Wn-86 x Lasani-08	38.79	4.48	78.46	3.86	14.42	0.49	34.42	2.14	18.47	0.95	75.79	7.52
Miraj-08 x SH-95	83.57	15.76	44.21	1.64	27.76	1.16	7.32	0.39	84.17	10.98	51.23	3.68
Miraj-08 x Faisalabad-08	78.06	11.75	37.38	1.45	69.23	3.82	53.74	6.06	40.24	2.15	64.18	6.23
Miraj-08 x Lasani-08	31.80	3.09	3.94	0.15	23.33	0.91	21.30	1.22	16.16	0.84	88.29	9.97

maturity. Early maturity is desirable trait in almost all crops. For days to maturity heritability estimates in broad sense ranged from 3.91-71.50%. While the values of genetic advance ranged from 0.11-4.56. The highest value of heritability (71.50%) was observed for cross Wn-81 x Faisalabad-08, having the associated value of genetic advance (3.48). While the lowest heritability estimates (3.91%) was observed in cross Wn-86 x Faisalabad-08, associated with the genetic advance of 0.11. Improvement in days to maturity is possible through selection. These results are similar to the findings of Ijaz *et al.* (2013), Ashraf *et al.* (2002) and Coskun *et al.* (2009).

Peduncle length: Variances of F_2 crosses ranged from 3.83-55.28 obtained for cross combination Wn-86 x Faisalabad-08 and Miraj-08 x SH-95, respectively. The highest value of C.V% 23.86 was obtained for cross combination Miraj-08 x SH-95 and the lowest value 7.19 was shown by Wn-86 x Faisalabad-08. These values indicate that high variability for peduncle length exists among crosses. The highest heritability estimates (84.17%) were recorded for the cross Miraj-08 x SH-95, having the highest value of genetic advance (10.98) while the lowest heritability estimates 7.79% was observed in the cross Wn-86 x Faisalabad-08, associated with genetic advance of 0.27, for peduncle length. Therefore, improvement is possible through intelligent selection. These results are similar to the findings of Subhani *et al.* (2000), Laghari *et al.* (2010) and Ijaz *et al.* (2013).

Number of tillers per plant: As it is clear from Table 2 that highest number of tillers per plant obtained for genotype Wn-81, i.e., 14 and the lowest value of number of tillers was obtained for SH-95, i.e., 8.60. Among F_2 crosses the highest number of tillers per plant was obtained for Wn-86 x Lasani-08 (12.13). C.V% for cross combinations ranged from 27.70-53.70, which shows that considerable amount of variability is present for this character. For number of tillers per plant heritability estimates in broad sense ranged from 6.59-78.62 %. While the values of genetic advance ranged from 0.39-8.30. The highest value of heritability (78.62%) was obtained in cross Wn-81 x SH-95 having the value of genetic advance (8.30). While the lowest heritability estimates 6.59% was observed in the cross Wn-86 x Faisalabad-08, coupled with genetic advance of 0.52. Low values of genetic parameters shows that it cannot be used as independent selection criteria. These results are in agreement with the findings of Fida *et al.* (2001), Khan *et al.* (2003) and Ijaz *et al.* (2013).

Grain yield per plant: Means, variances and C.V% of grain yield per plant is given in Table 2. Data in the table

indicates that the highest grain yield per plant is obtained for parental genotype Wn-81 (25.70) while the lowest grain yield is given by cross combination Wn-86 x Faisalabad-08 (7.19). Among F_2 crosses C.V% ranged from 28.92-49.68, given by cross combinations Wn-81 x SH-95 and Wn-81 x SH-95, respectively. The potential of wheat cultivar is determined by the grain associated characters (Sultana *et al.*, 2013). Grain yield per plant, heritability estimates in broad sense ranged from 13.54-88.29% while the values of genetic advance ranged from 1.13-10.63. The highest value of heritability (88.29%) was found for cross Miraj-08 x Lasani-08 having the value of genetic advance (9.97). While the lowest heritability estimates (13.54%) was observed in cross Wn-81 x Faisalabad-08, associated with the genetic advance of (1.13). High heritability and genetic advance indicate that more genetic components are involved. Selection will be suitable for the improvement of grain yield. Similar results were also reported by Ali *et al.* (2008), Waqar-Ul-Haq *et al.* (2008) and Ijaz *et al.* (2013).

CONCLUSION

It is concluded from this research that cross combination Wn-81 x Faisalabad-08 shows high estimates of heritability and genetic advance for days to maturity and peduncle length. While the crosses Wn-81 x SH-95 and Miraj-08 x Lasani-08 give high values of genetic parameters for number of tillers per plant and grain yield per plant respectively therefore these cross combinations and respective parents must be given due consideration in breeding programmes for the improvement of yield associated traits.

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