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Estimation of heritability and genetic advance for some yield traits in eight F_2 populations of wheat (*Triticum aestivum* L.)

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Abstract
Eight F_2 populations viz., Manthar-2003 × Fareed-2006, Manthar-2003 × 9444, Manthar-2003 × 9317, Manthar-2003× 9242, Fareed-2006 × 9317, Fareed-2006 × 9242, Fareed-2006 × 9444 and Fareed-2006 × Manthar-2003 involving five varieties/lines Manthar-2003, Fareed-2006, 9444, 9317 and 9242 were evaluated for the estimation of heritability and genetic advance of various yield traits. Broad sense heritability was varied from 51.72 to 80.11%, 40.26 to 77.96%, 50.21 to 84.51% and 54.48 to 80.91 and the range of genetic advance was from 1.59 to 3.36, 3.35 to 6.88, 0.17 to 0.74 and 3.55 to 6.88 for number of tillers per plant, number of grains per spike, grain weight per spike and grain yield per plant respectively. The cross combinations Fareed 06 × 9242, Manthar 03 × 9242 and parental line 9242 appeared to be the most promising. Therefore, selection among these crosses and parents for the improvement of grain yield per plant would give good results.
Key words: Wheat; F_2 population; broad-sense heritability; genetic advance; grain yield

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Introduction

Wheat (*Triticum aestivum* L.), belongs to *Poaceae* family, is the most important and major consumable food cereal of the world's populations including Pakistan. It is a staple food in many countries, including Pakistan. Wheat is considered as the most important crop in the formulation of agriculture policies and contributes to the value added agriculture (12.7 %) and GDP (2.6 %) [1]. During 2011-2012, wheat was planted on an area of 8.6 million hectares and its production was 23.5 million tons, averaging 2750 Kg/hec. In year 2011-2012, the wheat production was decreased from 25,214 thousand tons (2010) to 23,517 thousand tons, with a decrease of 6.5%. It was due to decline in the area of cultivation of wheat about 2.6 %. (Pakistan 2012) [1].

The basic aim of wheat breeders is to develop the wheat varieties that are genetically more stable, high yielding than existing ones and which are well adapted to a wide range of environments. The breeders of self-pollinated crops usually face three problems:

1. Identification of genetic material to be used as parents in the hybridization process for the improvement of desirable traits.
2. Selection of better performing genotypes in segregating generations and
3. Availability of genotypes used for the selection of additive type of variability from total genetic variability.

Wheat requirement is increasing continuously due to ever increasing population of the world. Competition among existing cultivars and advance lines of wheat has also shown up. Wheat genotypes with desired yield contributing traits need to be evaluated and selected for future breeding. Heritability estimates provide information about the extent to which particular plant characters such as plant height, number of tillers per plant, number of grains per spike, grain weight per spike (g), 1000-grain weight and grain yield per plant (g) are transmitted to the successive generations. Selection would be fruitful in the presence of high heritability. It measures the phenotypic variance which is attributable to the genetic cause. The heritability of the character determines the extent to which it is transmitted from one generation to the next generation. The knowledge of heritability helps the plant breeder in anticipating the behavior of the succeeding generation and provides a major component of response to the selection for a successful breeding program. Therefore, study was carried out to evaluate F_2 wheat population and assess various yield traits for available variation and to study heritability and genetic advance for the traits. This information will be helpful for improving the wheat yield through reliable selection.

Materials and Methods

The research work was carried out in the experimental area of the Department of Plant

Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during crop season 2012-2013. The experimental material was comprised of eight F_2 progenies involving five varieties/ lines of bread wheat (*Triticum aestivum* L.) as parents viz., Manthar-2003, Fareed-2006, 9444, 9317 and 9242. Whereas the F_2 progenies were Manthar-2003 × Fareed-2006, Manthar-2003 × 9444, Manthar-2003 × 9317, Manthar-2003× 9242, Fareed-2006 × 9317, Fareed-2006 × 9242, Fareed-2006 × 9444, Fareed-06 × Manthar-2003. The experiment was conducted in randomized block design with three replications. Seeds of F_2 populations along with their parents were spaced planted in lines with the help of dibbler, keeping plant to plant and row to row distance 15cm and 30 cm, respectively. Two seeds per hole were sown which later were thinned to one healthy seedling per hill after germination. The experimental material received standard agronomic and plant protection care. Plants were tagged and numbered to make them distinct from each other. At maturity two hundred healthy and competitive plants from F_2 population of each cross and 20 plants from each parent were taken at random for recording of data for number of tillers per plant, number of grains per spike, grain weight per spike (g) and grain yield per plant (g).

Statistical analysis

The data obtained for each plant attribute was tabulated and mean standard deviation, variance and coefficient of variability for parents and F_2 progeny were calculated. Broad sense heritability in percentage was measured by using the formula proposed by [2]:

$$h2\ (B.S) = \frac{VF2 - \sqrt{VP1\ x\ VP2}}{VF2} \times 100$$

Where:

h^2 = Heritability (broad sense);

VF_2 = Variance of F_2 population;

VP_1 = Variance of Parent 1 and

VP_2 = Variance of Parent 2

Genetic advance (GA) was computed by using the following formula:

$GA = \sigma P \times h^2 \times i$

Where:

GA = Genetic advance

σP = Phenotypic standard deviation of F_2 population

h^2 = Heritability in broad sense in fraction and

i = Constant value that reflects selection intensity

The value used for i in this study at 10% selection intensity was 1.755.

Results and Discussion

The estimates of mean, variance and coefficient of variability are shown in Table 1 while the estimates of heritability and genetic advance in Table 2 for various traits of F_2 population. The results of the present study are in agreement with [3-5] who suggested quantitative pattern of inheritance for plant height, number of tillers per plant, number of grains per spike, grain weight per spike, 1000 grain weight and grain yield per plant. The F_2 progenies exhibited a considerable amount of genetic variability for traits under study thus provides the opportunity to beneficial selection.

Plant height

It's evident from the results that the estimates of broad sense heritability for plant height varied from 20.03 to 84.12 %. Whereas, expected genetic advance ranged from 1.15 to 7.51. The highest value of heritability (84.12%) was recorded in cross combination Fareed 06 × Manthar 03 followed by the cross combination Fareed 06 × 9242 having value of heritability 76.32 %. While the lowest value of heritability (20.01%) was estimated in cross combination Fareed 06 × 9444. Similarly, the highest value of genetic advance was observed in cross combination Fareed 06 × 9242 having the value of 7.51. While the lowest value of genetic advance (1.15) was observed in cross combination Fareed 06 × 9444. Among the parental varieties/lines, Manthar 03 remained the dwarf (85.80 cm) and 9444 remained tall (107.33 cm). Among the F_2 crosses, the cross Manthar 03 × 9317 remained dwarf (92.28 cm) and the cross combination Fareed 06 × 9242 remained tall (103.74cm). The coefficient of variability was varied from 2.95 % (Manthar 03 × 9317) to 5.41% (Fareed 06 × 9242). The lowest value of variance (7.44) was observed in cross Manthar 03 × 9317 while the highest value of variance 30.41 was occurred in cross Fareed 06 × 9242. Our results are in accordance with the results of other researchers [5, 6].

Table 1: Means, variances and coefficients of variability for some yield traits in wheat

Genotypes	Plant height			Number of tillers per plant			Number of grains per spike			Grain weight per spike			1000-grain weight			Grain yield per plant		
	X	V	CV	X	V	CV	X	V	CV	X	V	CV	X	V	CV	X	V	CV
Manthar 03	85.8	2.1	1.7	11.6	2.3	13.0	53.1	6.0	4.6	2.4	0.2	16.3	40.2	0.1	0.8	24.8	10.6	13.1
Fareed 06	91.8	5.6	2.6	12.4	1.2	8.9	51.2	5.2	4.5	2.0	0.0	6.5	39.4	0.3	1.3	25.8	4.0	7.7
Manthar 03 × Fareed 06	92.7	9.5	3.3	12.6	4.3	16.5	54.3	23.8	9.0	2.5	0.2	16.3	42.3	0.3	1.4	27.5	16.7	14.9
Manthar 03	85.8	2.1	1.7	11.6	2.3	13.0	53.1	6.0	4.6	2.4	0.2	16.3	40.2	0.1	0.8	24.8	10.6	13.1
9444	107.3	8.7	2.8	12.9	1.6	9.7	54.9	8.9	5.5	2.2	0.1	11.2	39.9	0.0	0.4	25.5	4.7	8.5
Manthar 03 × 9444	100.1	13.1	3.6	12.6	4.3	16.5	53.8	12.2	6.5	2.5	0.2	19.1	42.3	0.3	1.4	27.0	33.1	21.3
Manthar 03	85.8	2.1	1.7	11.6	2.3	13.0	53.1	6.0	4.6	2.4	0.2	16.3	40.2	0.1	0.8	24.8	10.6	13.1
9317	93.8	8.4	3.1	11.6	1.0	8.5	54.9	8.9	5.5	2.1	0.0	8.2	38.8	0.0	0.4	24.1	9.9	13.0
Manthar × 9317	92.3	7.4	3.0	11.9	3.1	14.7	53.2	13.0	6.8	2.3	0.1	14.9	39.2	0.1	0.7	24.3	23.0	19.7
Manthar 03	85.8	2.1	1.7	11.6	2.3	13.0	53.1	6.0	4.6	2.4	0.2	16.3	40.2	0.1	0.8	24.8	10.6	13.1
9242	100.0	9.3	3.0	12.3	1.1	8.4	57.5	5.9	4.2	2.5	0.0	6.1	40.2	0.0	0.5	27.0	5.6	8.7
Manthar 03 × 9242	98.9	17.1	4.2	12.2	5.5	19.1	54.3	23.8	9.0	2.5	0.3	21.1	42.3	0.3	1.4	27.3	36.6	22.1
Fareed 06	91.8	5.6	2.6	12.4	1.2	8.9	51.2	5.2	4.5	2.0	0.0	6.5	39.4	0.3	1.3	25.8	4.0	7.7
9317	93.8	8.4	3.1	11.6	1.0	8.5	54.9	8.9	5.5	2.1	0.0	8.2	38.8	0.0	0.4	24.1	9.9	13.0
Fareed 06 × 9317	95.2	10.4	3.4	12.4	5.1	18.2	53.6	11.9	6.4	2.1	0.0	8.7	40.1	0.1	0.9	24.9	13.8	14.9
Fareed 06	91.8	5.6	2.6	12.4	1.2	8.9	51.2	5.2	4.5	2.0	0.0	6.5	39.4	0.3	1.3	25.8	4.0	7.7
9242	100.0	9.3	3.0	12.3	1.1	8.4	57.5	5.9	4.2	2.5	0.0	6.1	40.2	0.0	0.5	27.0	5.6	8.7
Fareed 06 × 9242	103.7	30.4	5.4	12.3	5.7	19.5	54.4	23.2	8.9	2.1	0.0	9.4	42.7	0.4	1.5	28.4	24.6	17.5
Fareed 06	91.8	5.6	2.6	12.4	1.2	8.9	51.2	5.2	4.5	2.0	0.0	6.5	39.4	0.3	1.3	25.8	4.0	7.7
9444	107.3	8.7	2.8	12.9	1.6	9.7	54.9	8.9	5.5	2.2	0.1	11.2	39.9	0.0	0.4	25.5	4.7	8.5
Fareed 06 × 9444	98.0	8.7	3.3	12.2	5.6	19.3	52.9	14.0	7.1	2.2	0.1	10.7	39.3	0.2	1.1	25.1	12.8	14.3
Fareed 06	91.8	5.6	2.6	12.4	1.2	8.9	51.2	5.2	4.5	2.0	0.0	6.5	39.4	0.3	1.3	25.8	4.0	7.7
Manthar 03	85.8	2.1	1.7	11.6	2.3	13.0	53.1	6.0	4.6	2.4	0.2	16.3	40.2	0.1	0.8	24.8	10.6	13.1
Fareed 06 × Manthar 03	93.3	21.7	5.0	12.3	5.4	19.0	54.0	25.3	9.3	2.3	0.3	22.1	41.9	0.9	2.3	25.5	20.9	17.9

Number of tillers per plant

The results showed that estimates of broad sense heritability for number of tillers per plant varied from 51.72 to 80.11 % (Table 2). Whereas expected genetic advance ranged from 1.59 t0 3.36. The highest value of heritability (80.12) was recorded in cross combination Fareed 06 × 9242 followed by the cross combination Fareed 06 × 9317 (78.63%). While the lowest value of heritability (51.72%) was estimated in cross combination Manthar × 9317. Similarly, the highest value of genetic advance was observed in cross combination Fareed 06 × 9242 having the value of 3.36. While the lowest value of genetic advance (1.59) was observed in cross combination Manthar × 9317. Among the F_2 crosses, the cross combination Manthar 03 × 9444 and Manthar 03 × Fareed 06 had maximum tillers per plant (12.58) and the cross Manthar × 9317 had the minimum tillers per plant (11.93). Among the parental varieties or lines, 9444 had maximum number of tillers per plant 12.93 followed by 9242 (12.34) while Manthar 03 had minimum tillers per plant (11.55). The coefficient of variability was varied from 14.67 % (Manthar × 9317) to 19.48% (Fareed 06 × 9242). The lowest value of variance (3.06) was observed in cross Manthar × 9317 while the highest value of variance (5.72) was occurred in cross Fareed 06 × 9242. Number of tillers per plant is a yield related trait, as it is directly related with the number of spikes per plant. Thus, the greater number of tillers per plant will ensure greater grain yield. The results are in confirmatory with the findings of Kumar et al [7].

Number of grains per spike

The results showed that the estimates of broad sense heritability for the number of grains per spike varied from 40.26 to 77.96 % (Table 2). Whereas, expected genetic advance ranged from 2.47 to 6.88. The highest value of heritability (77.96) was recorded in cross combination Fareed 06 × Manthar 03 having genetic advance value of 6.88. While the lowest value of heritability (40.26) was estimated in cross combination Manthar 03 × 9444 with genetic advance value of 2.47. The highest coefficient of variability (9.31%) was observed Fareed 06 × Manthar 03 and lowest value (6.41%) was recorded for cross Fareed 06 × 9317. The estimates of heritability were 76.51%, 76.04%, 75.00%, 51.15%, 43.63% and 42.46%, accompanied with genetic advance values 6.54, 6.42, 6.41, 3.35, 2.76 and 2.56 for crosses namely Manthar 03 × Fareed 06, Fareed 06 × 9242, Manthar 03 × 9242, Fareed 06 × 9444, Manthar × 9317 and Fareed 06 × 9317 respectively. The results are in accordance with the research findings of Rashidi [8].

Grains weight per spike

It is evident from Table 2 that the heritability estimates were moderate to high. The heritability estimates varied from 50.21 to 84.51 % associated with genetic advance 0.17 to 0.74. Highest heritability (84.51%) coupled with highest genetic advance (0.74) was observed for the cross combination Fareed 06 × Manthar 03. While the lowest value of heritability (50.21%) was associated with lower genetic advance (0.30) which was estimated in cross combination Manthar × 9317. Among the parental varieties or lines, Fareed 06 had minimum mean grain weight (2.01) and 9242 had maximum mean grain weight (2.45). Among the F_2 crosses, the cross Manthar 03 × 9444 had maximum mean grain weight per spike (2.51) and the cross Fareed 06 × 9317 had the minimum mean grain weight per spike (2.07).The Table 2 shows that the coefficient of variability was varied from 8.70% (Fareed 06 × 9317) to 22.12% (Fareed 06 × Manthar 03). The lowest value of variance (0.03) was observed in cross Fareed 06 × 9317 while the highest value of variance 0.27 was occurred in cross Manthar 03 × 9242. Similar results were obtained by Zecevic et al [9].

1000-grain weight

The values of heritability estimates varied from 39.91 to 86.45 percent associated with genetic advance 0.22 to 1.37, respectively. Highest heritability (86.45 %)

Table 2: Heritability percentages and genetic advance for some yield traits in wheat.

F_2 Populations	Plant Height		No. of tillers per plant		No. of grains per spike		Grain weight per spike		1000- grain weight		Grain yield per plant	
	h^2	GA	h^2	GA	h^2	GA	h^2	GA	h^2	GA	h^2	GA
Manthar03×Farced06	63.55	3.42	61.89	2.26	76.51	6.54	75.79	0.53	51.14	0.51	61.18	4.38
Manthar03×9444	67.15	4.25	56.46	2.06	40.26	2.47	58.75	0.49	86.45	0.86	78.69	7.94
Manthar03×9317	43.31	2.07	51.72	1.59	43.63	2.76	50.21	0.3	44.1	0.22	55.47	4.66
Manthar03×9242	74.09	5.37	71.79	2.95	75	6.41	79.71	0.73	80.83	0.81	79.06	8.39
Fareed-06×9317	34.13	1.93	78.63	3.1	42.46	2.56	52.86	0.17	39.91	0.25	54.48	3.55
Farced-06×9242	76.32	7.51	80.11	3.36	76.04	6.42	64.64	0.23	75.72	0.85	80.91	7.04
Fareed-06×9444	20.03	1.15	75.27	3.12	51.15	3.35	51.01	0.21	59.94	0.44	66.1	4.14
Fareed06×Manthar03	84.12	6.86	69.67	2.85	77.96	6.88	84.51	0.74	82.08	1.37	69.03	5.54

h2–heritability, G.A– genetic advance

coupled with high genetic advance (0.86) was observed for the cross combination Manthar 03 × 9444.While the lowest value of heritability (39.91%) associated with lowest genetic advance (0.25) was estimated in cross combination Fareed 06 × 9317 (Table 2). Among the parental varieties/ lines, 9317 had minimum 1000-grain weight (38.84g) and Manthar 03 had maximum 1000-grain weight (40.23g). Among the F_2 crosses, the cross Fareed 06 × 9242 had maximum 1000-grain weight (42.74g) and the cross Manthar 03 × 9317 had the minimum 1000-grain (39.17g). The coefficient of variability was varied from 0.71% (Manthar 03 × 9317) to 2.27% (Fareed 06 × Manthar 03). The lowest value of variance (0.08) observed in cross (Manthar 03 × 9317) while the highest value of variance 0.90 was occurred in cross (Fareed 06 × Manthar 03). High heritability was reported in cross combinations Manthar 03 × 9444, Fareed 06 × Manthar 03 and Manthar 03 × 9242. Our results are in accordance with the results of other researchers [10-12].

Grain yield per plant

It is obvious from Table 2 values that the values of heritability estimates varied from 54.48 to 80.91 percent associated with genetic advance 3.55 to 8.39. Highest heritability (80.91%) coupled with high genetic advance (7.04) was observed for the cross combination Fareed 06 × 9242.While the lowest value of heritability (54.48%) associated with lowest genetic advance (3.55) was estimated in cross combination Fareed 06 × 9317. Among the parental varieties or lines, 9317 had a minimum mean grain yield per plant (24.14) and 9242 had a maximum mean grain yield per plant (27.02). Among the F_2 crosses, the cross Fareed 06 × 9242 had maximum mean grain yield per plant (28.34) and the cross Manthar 03 × 9317 had the minimum mean grain yield per plant (24.28). The coefficient of variability was varied from 14.25% (Fareed 06 × 9444) to 22.14% (Manthar 03 × 9242). The results are in agreement with the research findings of Mangi et al [13].

Conclusions

The line 9242 appeared to be most promising among all the parental varieties/lines for most of the traits. It performs better for major yield contributing traits viz., tillers per plant, number of grains per spike, grain weight per spike and grain yield per plant. The cross combinations of 9242 also appeared to be most promising viz., Fareed 06 × 9242 and Manthar 03 × 9242 had moderate to high heritability coupled with high genetic advance for most of traits. This depicts the presence of additive gene action. Therefore, selection among these crosses for improvement of the grain yield per plant would give better results. The varying degree of transgressive segregation also occurred for these traits suggest that desirable gene combinations occurred in these F_2 populations and selection might be advantageous. Hence the promising crosses and the better performing parent would be given more importance in future breeding programs.

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