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HERITABILITY STUDIES FOR GRAIN YIELD AND YIELD COMPONENTS IN F_3 SEGREGATING GENERATION OF SPRING WHEAT

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Abstract

Heritability estimates provide information about the extent of which a particular genetic character to be transmitted to the successive generations. Heritability studies were conducted in four F_3 segregating populations originated through cross combinations of 6 wheat varieties/ advanced lines i.e., Sarsabz, Soghat-90, Marvi-2000, SI-91195, SD-1200/14 and IB-25/99 at the Nuclear Institute of Agriculture, Tando Jam during 2004-05. Genetic variance, environmental variance, heritability percentage in broad sense and genetic advance were estimated for different grain yield and yield contributing traits. The highest heritability (83.09%) associated with genetic advance (55.39) for grain yield was observed in cross combination of Marvi-2000 x Soghat-90 followed by Marvi-2000 x SI-91195 (80.0%; GA: 39.9), revealed good parental combination for effective selection for high yielding plants in segregating population.

Introduction

Bread wheat (*Triticum aestivum* L.) enjoys unique position among the cultivated crops firstly because it is grown on the area larger than any other crop; secondly, it provides more calories in human diet than any other crop; and thirdly, the world trade in wheat exceeds all other food grains. Creative human studies have produced tangible results in the evolution of new wheat varieties from the crosses of old and new varieties in view of an enhanced consumption pressure of growing population. Asia is the major sharer of the wheat production in the world. More than 40% of the total wheat production is produced in Asia (276.0 million tones) as compared to the world (684.6 million tones) production (Anon., 2009). China is major wheat producing (112.5 million tones) country in Asia followed by India and Pakistan (78.4 and 21.8 million tones respectively). However, average per hectare yield of wheat in our country is too low as compared to other countries. In Pakistan, during 2008-09, wheat was cultivated on 8.549 million hectares with average yield of 2451 kg/ha (Anon., 2008). The reduction in production of wheat stresses the need to develop genotypes with consistent performance over a wider range of environments.

Heritability study guide plant breeders to predict the interaction of genes in succeeding generations and thus provide a major component of response to selection for successful breeding programme. To improve the yield potential, various approaches have been adopted (Konzak 1987, Bajaj, 1990, Siddiqui *et al*., 1991, Snape, 1996, Arain *et al*., 2001, Teshale *et al*., 2003, Ahmedi and Bajelan 2008). Among which improvement of quantitative traits through hybridization has still been proven to be the most efficient way of selecting desirable traits in advanced segregating generations (Singh & Yunus, 1988).

Moreover, the extent of heritability of a quantitative trait is negatively correlated to environments (Sial *et al*., 2000). The selection capacity of the population mainly depends on the amount of heritable variation present and the extent to which it is transmitted from one generation to the next (Larik *et al*., 1999a).

Phenotypic variance, the total variance among genotypes when grown in a large number of environments, could be partitioned into genetic and environmental components to enable the breeders to design effective selection programmes (Dudley & Moll, 1969). The total genetic variance can further be sub-divided into additive genetic variance, dominance genetic variance and epistatic genetic variance (Suzuki *et al*., 1981). Heritability in the broad sense is the ratio of additive genetic variance to the phenotypic variance. Classically, the possible scope of selection and improvement is expressed in the terms of expected genetic advance (Gautam & Jain, 1985). Sharma *et al*., (1986) have expressed that the study of quantitative parameters in segregating generations provides a significant advancement in crop improvement. For effective selection, association of characters with yield and among themselves and the extent of environmental influence on the expression of these characters are necessary.

Materials and Methods

Experimental material consisting of 6 parents (Sarsabz, Soghat-90, Marvi-2000, SI-91195, SD-1200/14 and IB-25/99) and their four F_3 progenies (SD-1200/14 x IB-25/99, Soghat-90 x Sarsabz, Marvi-2000 x Soghat-90 and Marvi-2000 x SI-91195) of wheat (*Triticum aestivum* L.) were grown in the experimental field of Nuclear Institute of Agriculture Tando Jam in randomized complete block design (RCBD) with 2 replications during 2004-05. The soil at the experimental site was clay loam having pH 7.5. The recommended dose of fertilizer (100N: 50 P_2O_5 kg/ha) was applied to the experiment. The N fertilizer was applied in two splits while P fertilizer was used before the sowing. The seed was sown when soil came into wattar condition by dibbling method using single seed at the distance of 20cm between plants and 30cm spacing between rows. The sowing of the experiment was conducted 13th November 2004 (normal planting time). Five plants from each hybrid progeny and parental line per replication were selected at random for the study of yield and yield contributing characters. The experiment was irrigated four times during entire season viz., first irrigation was applied at tillering (after 21 days of sowing), second at booting stage (after 42 days of sowing), third at pre-anthesis stage (after 67 days of sowing) and the fourth and the last irrigation was applied during post-anthesis stage (after 90 days of sowing).The weeds were removed from the experiment manually, however no weedicide was applied for the eradication. The observations recorded were plant height, number of tillers per plant, spike length, spikelets per spike and grain yield per plant. Heritability estimates in broad sense (h^2 b.s), environmental variance (Ve) and genetic variance (Vg) were computed as suggested by Falconer (1977), while genetic advance (G.A) with a selection intensity of 5% was also calculated following method suggested by Singh & Chaudhry (1985).

Results and Discussion

The mean performance of hybrids and their parents is given in Table 1. The progeny SD-1200/14 x IB-25/99 was outstanding in performance for grain yield per plant (72.6g), number of spikelets per spike (27.5) and spike length (16.4cm); whereas, Soghat-90 x

Sarsabz produced maximum number of tillers per plant (28.1) and tall plants (105.8cm). However, dwarf plants (72.0cm) were produced by the progeny Marvi-2000 x Soghat-90. Wide variation was observed among different traits of wheat for heritability in the findings of Saleem *et al*., (2003), genetic advance ranging from 1.81 to 2.82 for spikelets per spike and heritability ranging from 58.38 to 79.09, while it ranged 63.31 to 90.86% for 1000-grain weight trait and genetic advance was observed about 7.90 to 21.51.

Genetic measures such as genetic variance, heritability (h^2 b.s) and genetic gain expected through selection pressure are presented in Table 2. Low to moderate and moderate to high estimates for these measures were found for the traits studied. The highest heritability (83.09%) coupled with high genetic advance (55.39) and considerable amount of genetic variance (869.59) were recorded for the hybrid Marvi-2000 x Soghat-90 showing promising combination for grain yield per plant. More than 90% heritability and genetic advance up to 11.61 for grain yield per plant character was recorded in wheat by Saleem *et al*., (2003). The combination could be used for bringing desirable improvement through selection, heritability estimates about the extent to which character is expected to be transmitted to the successive populations. Higher the heritabilities, more effective would be the selection and the higher estimates are attributed to fixable component of genetic variance (Larik *et al*., 1999b).

The highest heritability associated with high genetic advance for other characters like number of tillers per plant (h^2 = 95.44% G.A= 26.84), spike length (h^2 = 65.30 G.A= 2.37), number of spikelets per spike (h^2 = 65.10 G.A= 4.15) obtained in the same progeny (Marvi-2000 x Soghat-90) also confirmed the selection on the basis of these attributes of wheat (Table 2a, b). The high heritability values obtained in the hybrids for different characters offer the scope of selection in the population with respect to these traits. Large percentage of heritability and genetic gain provides confidence for selecting better plants with advantage even at early stage whereas, high coefficient of variability and genetic variance reflect the amount of variation and the chance of selection (Ansari *et al*., 1998).

The cross Marvi-2000 x Soghat-90 showed the higher value of coefficient of variability (Cv) for most of the traits i.e., number of tillers per plant, spike length, spikelets per spike and grain yield per plant (Table 1a-b). Mosaad *et al*., (1990), Ansari *et al*., (2000, 2003) and Ahmed *et al*., (2007) also reported high heritability for some agronomic traits and predicted the effective selection in early segregating population in wheat. However, same cross (Marvi-2000 x Soghat-90) did not show any increase in plant height as compared to other crosses, which might be due to the presence of same Rht genes in both the parents (Sial *et al*., 2002). Marvi-2000 x SI 91195 showed superiority to all the crosses in terms of heritability (h^2) in broad sense (96.51) coupled with genetic advance (45.7) and genetic variance (504.6) for the plant height. Similarly, this cross showed maximum heritability (80.00) (h^2b.s) with higher genetic advance (35.91) and ranked as the second useful cross after the Marvi-2000 x Soghat-90 for the grain yield per plant (Table 2b) whereas, heritability (h^2b.s) was not transferred in tillers per plant and spikelets per spike in the cross Marvi-2000 x SI-91195 (Table 2a and b). Heritability estimates reported by Nanda *et al*., (1982), Karaivanov & Kostova (1983), Krayljevic (1986) and Rehman & Kronstad (1992) indicated that certain components of grain yield in wheat are more heritable than others. The standard error (S.E) and coefficient of variability (Cv) was also higher (22.87 and 24.35 respectively) in this cross for the plant height (Table 1a).

Table 1a. Mean, standard error (S.E) and coefficient of variability (Cv) of some metric traits in F_3 segregating generations and their 6 parental lines of bread wheat for the yield contributing traits.

	Plant height (cm)		Number of tillers per plant		Spike length (cm)	
	Mean ± S.E	Cv	Mean ± S.E	Cv	Mean ± S.E	Cv
SD-1200/14	90.2 ± 2.39	8.36	19.1 ± 1.95	32.23	16.0 ± 0.39	7.80
IB-25/99	73.1 ± 1.63	7.05	19.8 ± 3.21	51.17	13.1 ± 0.02	5.34
Soghat-90	92.2 ± 1.01	3.48	14.7 ± 1.97	42.43	12.9 ± 0.40	9.88
Sarsabz	86.9 ± 2.65	9.65	13.1 ± 1.49	35.89	12.5 ± 0.27	6.80
Marvi-2000	87.4 ± 1.12	4.05	8.6 ± 0.99	36.45	16.8 ± 0.20	3.75
SI-91195	99.6 ± 1.55	4.91	20.9 ± 1.89	28.58	14.0 ± 0.43	9.68
SD-1200/14 x IB-25/99	95.3 ± 1.08	3.57	26.9 ± 3.01	35.29	16.4 ± 0.44	8.36
Soghat-90 x Sarsabz	105.8 ± 7.26	21.68	28.1 ± 4.06	45.65	13.8 ± 0.37	8.35
Marvi-2000 x Soghat-90	72.0 ± 4.36	19.14	23.3 ± 4.32	58.57	15.9 ± 0.56	11.04
Marvi-2000 x SI-91195	93.9 ± 7.24	24.35	18.7 ± 1.48	24.97	14.3 ± 0.37	8.23

Table 1b. Mean, standard error (S.E) and coefficient of variability (Cv) of some metric traits in F_3 segregating generations and their 6 parental lines of bread wheat for yield contributing traits.

	Number of spikelets per spike		Grain yield per plant (g)	
	Mean ± S.E	Cv	Mean ± S.E	Cv
SD-1200/14	24.2 ± 0.59	7.75	55.9 ± 7.45	42.08
IB-25/99	24.7 ± 0.33	4.29	32.8 ± 5.14	49.48
Soghat-90	22.0 ± 0.65	9.34	31.3 ± 7.31	73.81
Sarsabz	18.8 ± 0.61	10.28	28.3 ± 4.69	52.34
Marvi-2000	22.5 ± 0.40	5.64	20.6 ± 3.31	50.80
SI-91195	22.4 ± 0.76	10.78	22.3 ± 2.76	38.98
SD-1200/14 x IB-25/99	27.5 ± 0.62	7.12	72.6 ± 9.12	39.70
Soghat-90 x Sarsabz	21.4 ± 0.79	11.70	58.4 ± 7.07	38.22
Marvi-2000 x Soghat-90	24.3 ± 0.98	12.73	52.3 ± 10.24	61.83
Marvi-2000 x SI-91195	22.7 ± 0.33	4.67	61.1 ± 6.81	35.21

The cross SD-1200/14 x IB-25/99 showed higher heritability (92.21) for the number of tillers per plant (Table 2a). The maximum grain yield per plant (72.6g) obtained in this cross (SD-1200/14 x IB-25/99) seems to be attributed to the higher number of tillers per plant (26.9) (Table 1a and b). Heritability transfer ratio was observed very low in cross

Soghat-90 x Sarsabz (h^2b.s= 92.34) except for the plant height (Table 2a), indicated less chances of selection for the desirable yield contributing characters. Earlier studies pertaining to heritability and genetic advance in wheat have indicated variable results. Korkut & Jedynski (2001) recorded high estimates of heritability for plant height trait. This cross ranked as third high yielding (58g per plant), which might be due to the higher number of tillers per plant (28.1), but the genetic parameters could not be transferred properly in segregating generation. The low and moderate heritability values with high genetic variance values obtained in some of the segregants suggested that the selection may be delayed and the progenies can be critically examined in further generations (Ansari *et al*., 1998).

Table 2a. Values of genetic variance (Vg), heritability percentage (h^2 b.s), and genetic advance (GA) for yield and yield related traits of F_3 hybrids of bread wheat for yield contributing traits

	Plant height			Number of tillers per plant			Spike length		
	Vg	h^2	GA	Vg	h^2	GA	Vg	h^2	GA
SD-1200/14 x IB-25/99	00.00	00.00	00.00	830.75	92.21	18.06	0.89	47.13	1.36
Soghat-90 x Sarsabz	485.67	92.34	43.95	134.04	81.47	21.54	0.16	11.68	0.28
Marvi-2000 x Soghat-90	143.50	75.62	21.47	177.73	95.44	26.84	2.01	65.30	2.37
Marvi-2000 x SI-91195	504.61	96.51	45.70	00.00	00.00	00.00	0.27	19.79	0.49

Table 2b.Values of genetic variance (Vg), heritability percentage (h^2 b.s), and genetic advance (GA) for yield and yield related traits of F_3 hybrids of bread wheat for yield contributing traits.

	Number of spikelets per spike			Grain yield per plant		
	Vg	h^2	GA	Vg	h^2	GA
SD-1200/14 x IB-25/99	1.52	39.56	1.60	421.26	50.76	30.13
Soghat-90 x Sarsabz	2.29	36.61	2.98	122.16	32.43	14.93
Marvi-2000 x Soghat-90	6.23	65.10	4.15	869.59	83.09	55.39
Marvi-2000 x SI-91195	00.00	00.00	00.00	370.44	80.00	35.91

The present findings would suggest that the progenies Marvi-2000 x Soghat-90 followed by Marvi-2000 x SI-91195 crosses may be selected at this stage as better potential progenies due to the higher mean performance, besides high heritability coupled with high genetic advance capabilities. The progenies are therefore recommended for further evaluation and selection of high yielding segregants with desired traits in early segregating generations.

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