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GENETIC HERITABILITY FOR GRAIN YIELD AND ITS RELATED CHARACTERS IN SPRING WHEAT (*TRITICUM AESTIVUM* L.)

SHABANA MEMON, MUEEN-U-DIN QURESHI, BASHIR AHMED ANSARI AND MAHBOOB ALI SIAL[1]

Department of Plant Breeding and Genetics, Sindh Agriculture University, Tandojam, Pakistan
[1]Nuclear Institute of Agriculture (NIA), Tando Jam, Pakistan

Abstract

Seven F_3 progenies and their 8 parental lines of spring wheat were evaluated for some genetic parameters viz., coefficient of variability (Cv), genetic variance (Vg), heritability percentage (h^2 %) and genetic advance (GA) in 7 quantitative characters (grain yield and its associated traits). Highly significant ($p \leq 0.01$) differences were observed for all the characters viz. plant height, number of grains per spike, seed index and grain yield per plant among all the genotypes; indicating more variability. Differential responses for different characteristics were observed among the entire cross combinations. The highest heritability with more genetic advance for plant height, number of spikelets per spike and number of grains per spike were observed in progeny Khirman x RWM-9313. Two progenies Soghat-90 x Sarsabz and Marvi-2000 x Soghat-90 showed more number of tillers per plant, spike length and grains per spike with more heritability and genetic gain. The parental line Khirman (a drought-tolerant variety) showed outstanding performance with respect to more number of tillers per plant (12.6) and grain yield per plant (25.6) also combining acceptable genetic parameters.

Introduction

Wheat (*Triticum aestivum* L.) is the most important food crop of the world including Pakistan and ranks first among all the cereals. In Pakistan, it occupies around 8.5 million hectares with annual production of 21.0 million tones (Anon., 2005). Wheat yields of the country are much lower as compared to many other countries of the world due to abiotic (environmental stresses particularly high temperatures, drought and salinity) and biotic (diseases etc.) factors (Arain *et al.*, 1999; Reynolds *et al.*, 2001; Khan *et al.*, 2003; Sial *et al.*, 2005). To overcome the consumption pressure of ever increasing population, the wheat breeders are concentrating their efforts to improve the yield potential of wheat by developing new varieties with desirable genetic make up. The high heritability associated with high genetic advance for main quantitative traits in wheat offer better scope of selection of genotypes in early segregating generations (Singh & Chatrath 1992; Memon *et al*., 2005). Wheat breeders are utilizing available genetic resources to reconstruct the ideotype of plant to meet the ever increasing requirements of the population. In this regard heritability estimates plays an important role for planning the breeding strategy. The heritability of the character determines the extent to which it is transmitted from one generation to the next and it is most valuable tool when used in conjunction with other parameters in predicting genetic gain that follows in the selection for that characters (Afiah *et al*, 2000; Baloch *et al*, 2003; Ansari *et al*, 2004, 2005). The heritability values become a measure of the genetic relationship between parents and progeny; hence considerable research work has been carried out to incorporate the desirable genes in present wheat varieties to increase the productivity of the crop. Similarly, the semi-dwarfing or reduced height genes Rht_1 (Rht-B1b) and Rht_2 (Rht-D1b) have been extensively exploited for developing high yielding varieties with grain yield associated traits such as reduced plant height and lodging resistance (Gale & Youssefian, 1985; Rebetzke & Richards, 2000; Sial *et al.*, 2002). Present research work was therefore conducted to evaluate the F_3 segregating progenies of wheat to determine the genetic parameters and their relative proportion of transfer of genetic information in various quantitative traits. Such information generated through the research work will be helpful in selection of hybrids/segregants developed from various cross combinations with known genetic background and desired quantitative traits in successive generations.

Materials and Methods

Seven F_3 progenies (Khirman x Kiran 95, RWM-9313 x Kiran 95, Marvi-2000 x Soghat-90, Khirman x RWM-9313, Marvi-2000 x Khirman, SD-1200/14 x IB 25/99, Soghat-90 x Sarsabz) developed through different cross combinations of 8 parental lines of bread wheat (*Triticum aestivum,* L.) were screened to study their genetic parameters. The experiment was carried out at Wheat Breeding Station at Nuclear Institute of Agriculture (NIA) Tandojam in randomized complete block design (RCBD) with three repetitions during wheat cropping season 2002-2003. Each genotype was sown by single seed dibbler method in 5 rows 3m long; keeping distance of 25 cm between rows and 20 cm within plants for each genotype. Ten plants were selected at random and indexed to record the data for quantitative traits. Grain yield and its associated characters viz., plant height (cm), number of tillers per plant, spike length (cm), number of spikelets per spike, number of grains per spike, seed index (100 seed weight g) and grain yield per plant were studied. Mean squares (MS) and Duncan's Multiple Range Test (DMRT) were calculated by analyzing data using analysis of variance (ANOVA). Genetic parameters viz., heritability percentage (h^2 %), genetic advance (GA), genetic variance (Vg) and coefficient of variation (Cv) were calculated for the quantitative traits as suggested by Falconer (1989) and modified by Ansari *et al*., (2004).

Results and Discussion

Overall mean performance of all the parental lines and F_3 segregating progenies for different quantitative traits has been given in Table 1. Different parental lines and cross progenies showed significant ($p \leq 0.01$) differences observed for overall studied characters. All the parental varieties and progenies were semi-dwarf in nature; their plant height ranged between 70.2 to 106.2 cm. Number of tillers per plant, an important yield component is playing a vital role in increasing the final grain yield. More number of tillers/plant (12.6) was produced by parental line Khirman; whereas, less number of tillers (4.1) was observed in Marvi-2000. To some extent, few progenies showed hybrid vigor over their parental varieties. However, single F_3 progeny Khirman x RWM-9313 had more combining ability for number of tillers per plant (10.4) as compared to other progenies, hence, it might be high yielding progeny due to more spikes per unit area. The more tillers in this progeny could be attributed to its mother variety Khirman which produced more number of tillers. Spike length ranged between 9-12.7 cm in all cross progenies and parental lines. Longer spikes were observed in Marvi-2000 x Soghat-90 progeny followed by SD 1200/14. The smaller spikes (9 cm) as compared to their both parents were observed in three progenies: RWM-9313 x Kiran-95, Soghat-90 x Sarsabz and Khirman x Kiran-95 (Table 1). Moreover, numbers of spikelets were higher in Marvi-2000 x Soghat-90. The more spikelets in this progeny could be due to Soghat-90 (parental line). Marvi-2000 had more number of grains per spike (71.2) followed by

Table 1. Mean squares of 7 yield and yield components of spring wheat (*Triticum aestivum* L.).

Source of variation	DF	Plant height (cm)	Number of tillers/plant	Spike length (cm)	Number of spikelets/spike	Number of grains/spike	Seed index	Grain yield/ plant
otypes	14	310.47**	18.02**	4.48**	20.50**	186.08**	0.44	72.41**
lications	2	7.5	0.22	0.08	2.26	67.50	0.04	1.09
r	28	11.81	0.39	0.39	1.04	17.23	0.07	6.77
D at p< 0.01	--	5.752	2.091	1.046	1.704	6.948	0.437	4.356

Table 2. Mean performance of 7 F_3 progenies of spring wheat for yield components.

otypes	Plant height (cm)	Number of tillers/plant	Spike length (cm)	No. Spikelets/ spike	No. of grains/spike	Seed index (g)	Grain yield/ plant (g)
rman	90.4 d	12.6a	11.3bc	18.5d	54.7b	4.5ab	25.7 a
n-95	88.3 de	8.8bcd	9.6e	15.1f	46.2cd	4.1bcde	14.7 cde
M-9313	80.4 ef	7.8d	9.5e	16.1ef	52.8bc	4.1bcde	14.7 cde
vi-2000	98.7 b	4.1g	11.8ab	19.5cd	71.2a	5.1a	11.0 fgh
hat-90	97.8b	7.1def	11.4bc	21.6b	57.7b	4.2bcd	15.9 cde
1200/14	98.3b	5.6fg	12.1ab	20.7bc	67.6a	4.4bc	11.5 efg
5/99	83.3e	5.7efg	9.9de	20.7bc	53.7b	4.1bcde	9.5gh
abz	93.3cd	10.8ab	11.3bc	16.8e	56.0b	3.9def	18.0 bc
rman x Kiran-95	88.5d	7.9b	9.9de	15.5ef	45.5d	4.3bc	14.2 cde
M-9313 x Kiran-95	89.4d	5.2g	9.0e	15.9ef	52.5bc	3.9cde	8.3 h
vi-2000 x Soghat-90	75.3fg	8.5cd	12.7a	24.1a	67.9a	3.7fg	17.2bcd
rman x RWM-9313	74.4g	10.4bc	11.9ab	19.5cd	64.7a	3.8efg	20.7b
vi-2000 x Khirman	70.2g	5.3g	10.7cd	19.9c	57.0d	3.6g	8.4h
1200/14 x IB 25/99	83.4de	4.8g	11.5bc	19.1cd	56.2b	4.0cde	9.2gh
hat-90 x Sarsabz	106.2a	7.7de	9.3e	16.5ef	57.5b	4.5ab	13.2def

: 3a. The values of heritability percentage (h^2%) in broad sense, coefficient of variability (CV) and genetic variance (Vg) of seven F_3 progenies of genetic advance (GA), spring wheat for yield component.

;enies	Plant height (cm)				No. of tillers per plant				Spike length (cm)			
	CV	Vg	h^2 %	GA	CV	Vg	h^2 %	GA	CV	Vg	h^2 %	GA
n x Kiran-95	6.1	20.2	68.9	7.7	54.3	10.0	56.6	4.9	12.9	1.0	52.3	1.4
)313 x Kiran-95	0.1	12.6	56.5	5.5	34.5	10.0	56.6	4.9	12.1	0.0	15.3	0.3
!000 x Soghat-90	16.8	20.3	56.5	15.0	69.7	33.0	93.8	11.5	16.6	3.0	64.2	2.8
n x RWM-9313	15.0	11.6	92.4	21.0	36.5	7.0	47.6	3.7	12.1	81.0	38.9	1.2
!000 x Khirman	20.6	15.2	72.9	22.0	33.7	7.0	47.6	3.7	15.7	2.0	58.1	2.0
0/14 x IB-25/99	4.4	15.2	72.9	22,0	42.5	3.0	63.2	2.7	7.8	2.0	58.1	2.0
90 x Sarsabz	4.1	15.2	72.9	22.0	39.9	6.0	65.4	4.1	16.2	2.0	58.1	2.0

3b.The values of heritability percentage (h^2%) in broad sense, genetic advance (GA), coefficient of variability (CV) and genetic variance (Vg) of seven F_3 progenies of spring wheat for yield component.

;enies	No. of spikelets per spike				No. of grains per spike				Seed index (g)			
	CV	Vg	h^2 %	GA	CV	Vg	h^2 %	GA	CV	Vg	h^2 %	GA
n x Kiran-95	9.1	0.0	0.0	0.0	15.5	0.0	0.3	0.1	7.8	0.0	0.0	0.0
)313 x Kiran-95	12.1	0.7	20.0	0.8	11.2	0.0	0.3	0.1	14.8	0.0	70.1	0.8
!000 x Soghat-90	12.3	0.1	46.1	2.8	26.7	0.0	77.2	28.9	14.5	0.0	38.7	0.4
n x RWM-9313	11.3	2.0	41.3	1.9	10.8	79.0	68.6	15.2	13.1	0.0	25.8	0.1
!000 x Khirman	13.9	4.9	63.1	3.6	29.9	0.0	82.9	29.2	19.8	0.0	54.7	0.8
0/14 x IB-25/99	13.7	2.9	47.8	2.5	14.2	0.0	82.9	29.2	19.1	0.0	73.5	0.7
90 x Sarsabz	11.6	2.9	47.8	2.5	20.5	78.0	56.9	13.8	8.2	0.0	54.5	0.7

SD1200/14 and two progenies Marvi-2000 x Soghat-90 and Khirman x Kiran-95 and RWM-9313. Kiran-95 had fewer grains per spike (46.2) as compared to other parental lines and progenies; hence both progenies (Khirman x Kiran-95 and RWM-9313 x Kiran-95) obtained from the cross of Kiran-95 had less grains per spike. In parental lines, seed index (1000-grain weight) ranged from 3.9g in Sarsabz to 5.1g in Marvi-2000. The parental variety Khirman had highest seed index (4.5g) after Marvi-2000 taking seed index in consideration in all progenies, the highest seed index was obtained in Soghat-90 x Sarsabz followed by Khirman x Kiran-95. The highest grain yield (20.7g) as compared to other progenies was recorded in Khirman x RWM-9313. The highest grain in Khirman could be due to more number of tillers per plant and higher seed index. IB 25/99 proved to be the poor yielding parental line (9.5g plant yield), could be due to less tillering efficiency with smaller spikes. Three progenies Khirman x RWM-9313, Marvi-2000 x Soghat-90 and Khirman x Kiran-95 had more grain yield per plant as compared to other progenies included in this comparison. The more grain yield in Khirman x RWM-9313 and Marvi-2000 x Soghat-90 progenies could be due to significantly more grains per spike, longer spikes, more tillering capacity and more spikelets per spike. The other progenies were inferior for all the traits.

Table 2 shows that the 7 F_3 progenies along with their 8 parental lines differed significantly at $p \leq 0.01$ for all the characters viz., plant height (cm), number of tillers per plant, spike length (cm), number of spikelets per spike, number of grains per spike, seed index (1000 seed weight g) and grain yield per plant thus indicated the existence of great genetic variability among the genotypes for various characters. The progenies exhibiting superior values in most of the desired yield components may be selected for further evaluation in advanced segregating generations, even in advanced yield trials and adaptability studies. (Camargo *et al.,* 2000, Ansari *et al.,* 2005.

The results regarding genetic selection parameters viz., coefficient of variability, heritability percentage in broad sense and genetic advance at 5% selection intensity are presented in Table 2. Genetic parameters studied in F_3 progenies were calculated according to the method described by Falconer (1989). Different characters attributed different results in all the progenies for genetic parameters especially for grain yield per plant. For the plant height character the progeny Khirman x RWM-9313 revealed the highest heritability percentage associated with high genetic advance (h^2 % 93.80 and G.A 11.50) reflecting the large heritable variances offered the possibility of the improvement through selection (Ansari *et al.,* 2004). The progeny Marvi-2000 x Soghat-90 and Soghat-90 x Sarsabz revealed the highest heritability percentage alongwith high genetic advance for different important traits viz., number of tillers per plant, spike length and number of spikelets per spike. Memon *et al.,* 2005 reported that the expression of the trait number of tillers depended on its genetic control in their parents hence transgressed to their hybrids. Similarly, for the parameters number of grains per spike and seed index Marvi-2000 x Soghat-90, Marvi-2000 x Khirman and Soghat-90 x Sarsabz showed highest heritability percentage with high genetic gain as the results showed that the semi-dwarf varieties responded with reduced straw height and higher yields as a consequence to more grains per spike (Borner & Menial 1993). Grain yield a complex character was seen to be effective in few progenies as in Khirman x RWM-9313, Marvi-2000 x Soghat-90, Marvi-2000 x Khirman and Soghat-90 x Sarsabz which displayed prominent performance for grain yield per plant influencing high to moderate heritability with high genetic advance. Sharma *et al*., (1995) suggested that grain yield was significantly associated with plant height and number of grains per spike. Similarly, Rajper & Ansari (2004) evaluated important quantitative traits for different progenies and found high to moderate heritability and genetic advance for grain yield per plant. Present findings are corroborated with the findings of Patel & Jain (2002), Kumar *et al*., (2003), Kumar & Mishara (2004) who also observed high heritability with high genetic advance and suggested the selection at an early segregating generation which will prove beneficial for selecting superior lines of wheat. The low heritabilities associated with low genetic advance as observed in some of the progenies is also similar to the findings of Singh *et al*., (2001), Gupta *et al*., (2004) and Ansari *et al*., (2005).

The present results suggested that the progenies Khirman x RWM-9313, Marvi-2000 x Soghat-90 and Soghat-90x Sarsabz may be selected due to their better mean performance and high heritability coupled with high genetic advance in most of the characters, hence may be promptly selected for evolving high yielding genotypes of wheat.

Table 3c. The values of heritability percentage (h^2%) in broad sense, genetic advance (GA), coefficient of variability (CV) and genetic variance (Vg) of 7 F_3 progenies of spring wheat for yield component.

F_3 progenies	Grain yield per plant (g)			
	CV	Vg	h^2 %	GA
Khirman x Kiran-95	51.9	17.8	32.7	5.0
RWM-9313 x Kiran-95	32.1	17.8	32.7	5.0
Marvi-2000 x Soghat-90	72.2	13.4	86.5	22.0
Khirman x RWM-9313	40.9	40.4	56.2	9.8
Marvi-2000 x Khirman	40.1	40.4	56.2	9.8
SD-1200/14 x IB-25/99	51.3	15.9	72.1	7.0
Soghat-90 x Sarsabz	41.0	19.0	64.5	7.2

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