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STUDY OF GENETIC PARAMETERS IN SEGREGATING POPULATIONS OF SPRING WHEAT

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Abstract

The estimation of heritability of important agronomic characters has a great significance with selection for superior genotypes. A field experiment was conducted to evaluate 7 F_4 progenies of bread wheat (*Triticum aestivum* L.), developed from 8 parental lines at the experimental field of Nuclear Institute of Agriculture (NIA) Tandojam. Six different yield contributing characters viz., plant height, number of tillers per plant, spike length, number of grains per spike, seed index (1000-grain weight) and grain yield per plant were studied. All the genotypes differed significantly ($p \geq 0.01$) from each other for all the measured characters; which indicated the existence of genetic variability among the material studied. The progenies Marvi-2000 x Soghat-90 and Khirman x RWM-9313 have proven to be the best combiner progeny with potential to transfer the highest heritability (h^2 b.s) associated with high genetic advance (GA) for yield and its related characters. Therefore these transgressive segregates could be selected towards the improvement of wheat crop.

Introduction

Wheat (*Triticum aestivum* L.) is the primary source of staple diet for poor and rich alike and is the leading food in many areas of the world. It provides 20 % food calories to the world. In Pakistan, it covers around 8.5 million hectares with annual production of 23.5 million tones (Anon., 2007). The main environmental constraints for the wheat crop throughout the world are drought, salinity and heat stresses (Nachit & Ouassou, 1988; Savin & Nicolas, 1999; Richards *et al.,* 2001; Reynolds *et al*., 2001; Najafian *et al*, 2004; Sial *et al.,* 2005).

The grain yield is a complex character and is influenced by genotype, environment and genotype x environment interaction (Sial *et al.,* 2007). Increased yield of crops is of prime concern to the breeders in any crop-breeding programme. Wheat breeders all over the world have been utilizing the available genetic resources to modify the existing varieties to meet the ever-changing requirements. The breeders to develop varieties that suit their particular requirements have used the strains, which possess wide range of variability in important yield characters. This approach has become more fascinating with the passage of time as the knowledge of mechanism of heredity becomes well understood and the means of communication become better developed. Therefore, it is important to determine the genetic performance of newly evolved breeding material.

Study of genetic parameters from segregating population is useful in understanding the genetic consequences of hybridization and inbreeding. The heritability of a character describes the extent to which it is transmitted from one generation to the next. The genetic advance is the further estimation of expected gain resulting from selection pressure in breeding material. Phenotypic and genotypic variance (Vp and Vg), heritability (h^2 b.s) and genetic advance (GA) have been used to assess the magnitude of variance in wheat breeding material (Khan, 1990, Zaheer *et al*., 1987). High heritability associated with high genetic advance for different yield components have a better scope for selecting high yielding genotypes (Rajper *et al*., 1990). Genetic information like heritability and genetic advance of different yield contributing factors would be of great value enabling the breeder to use best genetic stock for improvement in a planned breeding programme.

In bread wheat, many studies have been performed to estimate broad sense heritability for evaluation of hybrid population (Krupnova & Bebyakin, 1991; Larik *et al*., 1999; Pawar *et al*., 1988; Singh & Yunus 1988; Ansari *et al*., 2002). The present study embodies the estimation of genetic parameters such as coefficient of variability, genetic variance, heritability in broad sense and genetic advance for yield and yield related characters of wheat hybrids.

Materials and Methods

The research work was carried out at the experimental field at Nuclear Institute of Agriculture (NIA) Tandojam during wheat growing season 2002-03. The experimental material comprised of 8 varieties/parental lines of wheat viz., Bhittai, IB 25/99, Soghat-90, RWM-9313, Kiran-95, Khirman, Marvi-2000 and Sarsabz alongwith F_4 segregating population of their 7 progenies viz., Bhittai x IB-25/99, Soghat-90 x Sarsabz, Marvi-2000 x Soghat-90, Khirman x RWM-9313, Khirman x Kiran-95, RWM-9313 x Kiran-95 and Marvi-2000 x Khirman. The experimental material was screened in the field by using Randomized Complete Block Design (RCBD) with three replications. Four rows, three meter long of each genotype per replication were grown keeping 15cm space between plants and 30 cm between the rows. Data on grain yield and yield associated characteristics i.e, plant height, number of tillers per plant, spike length, number of grains per spike, seed index (1000-grain weight), and grain yield per plant was recorded and statistically analysed. Analysis of variance was applied to the data according to method suggested by Steel & Torrie (1980) and the means were compared using Duncan's Multiple Range Test (DMRT) as suggested by Duncan (1955). The heritability parameters were computed according to Falconer (1977). The legends of the formula shown by Larik *et al*., 1989:

$$\text{Coefficient of variability (Cv)} = \frac{\text{S.D x 100}}{\text{X}}$$

$$\text{Genetic variance (Vg)} = VF_4 - Ve$$

$$\text{Environmental variance (Ve)} = (VP_1 + VP_2)/2.$$

$$h^2 = \frac{VF_4 - (VP_1 + VP_2)/2}{VF_4} \text{ X } 100$$

Genetic advance (GA) = K x (H) x SD

Where, V = variance F_4 = forth filial generation, and P = parent.

K = Constant (2.06) for selection difference at 5% selection intensity.
Ve = Environmental variance.
Vg = Genetic variance
Vp_1 = Variance of parent one
Vp_2 = Variance of parent two
H = Heritability coefficient
h^2%= Heritability percentage in broad sense.
S.D = Phenotypic Standard Deviation
GA = Genetic advance.

Results and Discussion

The combined analysis of variance for all the genotypes (including 8 parents and their 7 F_4 progenies) depicted that both the parents and segregating populations differed significantly at $p \geq 0.01$ for most of the characters under study, indicating the existence of great genetic variability among the genotypes (Table 1). The highest plant yield (31.01g) was produced by a parental line RWM-9313 followed by Khirman (25g) and the population of cross Khirman x RWM (23.4g). The possible reason for the high grain yield could be due to more number of tillers (Table 2). However, the highest seed index value (48g 1000-grain weight) was observed in Marvi-2000 x Khirman cross, but due to less number of tillers, smaller spikes and less number of grains per spike it produced lower grain yield per plant. Two progenies Soghat-90 x Sarsabz and Khirman x RWM-9313 showed hybrid vigour for the plant height character over their parents, both the combinations produced tall plants (122.7 and 116.2 cm) respectively. Whereas, both the progenies did not show superiority over any character than their parents. Similar trend was noted in Khirman x Kiran-95 and RWM-9313 x Kiran-95, both the progenies remained inferior to other genotypes/crosses. The dwarf plants (73.6 cm) and maximum number of grains per spike (68.9) were recorded in the combination of the cross of Marvi-2000 x Soghat-90. The progeny of Bhittai x IB-25/99 produced the longer spikes (12.7 cm).

The results presented in Table 3 (a) show that the cross Marvi-2000 x SI-91195 and by Marvi-2000 x Soghat-90 had the highest heritability (h^2 b.s=92.6 and 91.4 respectively) and genetic advance (GA=19.0 and 24.8 respectively) for the trait plant height. This indicates that plant height trait can be efficiently transferred in the hybrid progeny of this cross. Marvi-2000 x Khirman progeny has also shown maximum genetic variability (Vg=92.30) for plant height, but this cross has not shown any significant response to other traits viz., tillers per plant, spike length, number of grains per spike, 1000-grain weight and grain yield per plant in terms of genetic variance (Vg), heritability % (h^2 b.s) and genetic advance (GA) (Table 3).

Number of tillers per plant is the main yield contributing trait; the highest heritability coupled with genetic advance for this trait was obtained in the hybrid population of Marvi-2000 x Soghat-90 followed by Khirman x RWM-9313. Khirman x RWM-9313 and Marvi-2000 x Soghat-90 had superiority on genetic parameters as for as the length of spikes (cm) is concerned. RWM-9313 x Kiran-95 followed by Marvi-2000 x Soghat-90 crosses had maximum heritability (h^2 b.s) and genetic advance (GA) for number of grains per spike and Marvi-2000 x Soght-90 progeny had the highest heritability values for 1000-grain weight and grain yield per plant.

Table 1. Analysis of variance showing squares (M.S) of 7 F_4 progenies and their 8 respective parents for 6 metric traits of wheat.

Source of variation	D.F	Plant height	Number of tillers per plant	Spike length	Number of grains per spike	Seed index (1000 seed wt)	Yield per plant
Genotypes	14	527.7**	19.6**	4.28**	230.1**	0.53**	138.3**
Replications	2	0.335	0.51	0.22	22.155	0.015	0.055
Error	28	9.176	1.181	0.25	16.875	0.033	5.149

** = Significant at p≥0.01 level of probability.

Table 2. Mean performance of seven F_4 progenies and their eight parental lines for important quantitative characters of wheat

Genotypes	Plant height (cm)	Number of tillers per plant	Spike length (cm)	Number of grains per spike	Seed index (1000 seed wt. g)	Yield per plant (g)
Bhittai	97.0 cd	6.27 cde	13.2 a	66.5 bc	40.8 efg	14.8 c
IB-25/99	82.2 hi	5.20 de	10.9 ef	57.9 de	34.7 j	8.5 e
Soghat-90	99.8 c	6.60 cd	11.9 bcd	57.9 de	43.6 cde	14.8 c
RWM-9313	99.5 c	12.40 a	11.9 bcd	63.7 bcd	46.3 abc	31.0 a
Kiran-95	77.2 ij	5.87 cde	10.2 fghi	47.4 f	36.1 ij	8.9 e
Khirman	93.1 de	11.20 a	10.7 efg	61.5 cde	45.1 bcd	25.4 b
Marvi-2000	84.2 gh	5.73 cde	12.9 a	76.8 a	46.7 ab	16.4 c
Sarsabz	90.8 ef	5.67 de	10.6 efgh	47.7 f	41.3 ef	10.1 e
Bhittai x IB-25/99	97.0 cd	4.53 e	12.7 ab	62.9 bcd	39.5 fgh	9.4 e
Soghat-90 x Sarsabz	122.7 a	8.60 b	11.8 cd	60.2 cde	36.5 hij	14.2 cd
Marvi-2000 x Soghat-90	73.6 j	7.53 bc	11.2 de	68.9 b	38.0 ghi	15.0 c
Khirmanx RWM-9313	116.2 b	11.07 a	12.5 abc	57.7 de	45.3 bcd	23.4 b
Khirmanx Kiran-95	88.2 efg	6.47 cd	9.5 i	42.5 f	40.0 fg	10.0 e
RWM-9313 x Kiran-95	87.5 fg	4.93 de	9.9 ghi	54.8 e	42.4 def	9.4 e
Marvi-2000 x Khirman	100.5 c	4.53 e	9.9 hi	57.8 de	48.3 a	10.9 de
LSD at 5%	5.07	1.82	0.84	6.88	03.0	3.80

Means with similar letters do not differ from each other at 0.05 level of probability.

Table 3(a). Coefficient of variability (Cv), genetic variance (Vg), heritability percentage (h^2 b.s) and genetic advance (GA) for the traits plant height and number of tillers per plant of 7 F_4 progenies of wheat.

F_4 Progenies	Plant height (cm)				Number of tillers per plant			
	Cv	Vg	h^2	GA	Cv	Vg	h^2	GA
Bhittai x IB -25/99	7.50	43.60	82.51	12.35	38.89	0.72	23.02	0.84
Soghat-90 x Sarsabz	10.16	136.52	87.82	22.55	38.01	7.65	71.62	4.82
Marvi-2000 x Soghat-90	17.94	159.10	91.39	24.84	47.56	10.39	80.94	5.97
Khirmanx RWM-9313	6.27	37.79	71.21	10.68	42.53	17.50	78.77	7.65
Khirman x Kiran-95	5.26	8.63	40.06	3.83	48.13	6.33	65.32	4.19
RWM-9313 x Kiran-95	8.05	28.37	57.22	8.30	49.93	2.88	47.42	2.41
Marvi-2000 x Khirman	9.93	92.30	92.65	19.04	28.72	--	--	--

The highest mean grain yield values for coefficient of variability, moderate to high genetic variance and high to moderate heritability estimates, which indicated that it seems to be very difficult to select a promising line in early generations on the basis of grain yield only (Table 3b). The yield is a total of genetic expression of all the yield components and believed to be a very complex character and its manifestation is influenced by the environmental as well as physiological factors (Rajper *et al.,* 1990; Sial *et al*., 2003; Slafer *et al*., 1994; Rebetzke & Richards, 1999). Low and moderate heritability with high coefficient of variability and genetic variability values recorded in some of the progenies suggested that the selection may be delayed and the progenies be critically examined in further generations (Ansari *et al*., 1998).

Table 3(b). Coefficient of variability (Cv), genetic variance (Vg), heritability percentage (h^2 b.s) and genetic advance (GA) for the traits spike length and number of grains per spike of 7 F_4 progenies of wheat.

F_4 Progenies	Plant length (cm)				Number of tillers per plant			
	Cv	Vg	h^2	GA	Cv	Vg	h^2	GA
Bhittai x IB -25/99	8.25	0.25	22.89	0.49	12.42	--	--	--
Soghat-90 x Sarsabz	8.10	0.12	13.09	0.26	12.78	20.60	34.82	5.51
Marvi-2000 x Soghat-90	17.20	2.25	60.97	2.42	26.29	189.29	57.74	21.52
Khirmanx RWM-9313	11.98	1.60	71.49	2.20	13.62	22.50	36.49	5.91
Khirman x Kiran-95	9.46	0.36	43.83	0.81	13.84	0.08	0.22	0.02
RWM-9313 x Kiran-95	10.52	0.53	48.12	1.03	17.56	68.22	73.68	14.61
Marvi-2000 x Khirman	17.14	--	--	--	14.73	--	--	--

Table 3(c). Coefficient of variability (Cv), genetic variance (Vg), heritability percentage (h^2 b.s) and genetic advance (GA) for the traits seed index (1000-grain weight g) and rain yield per plant of 7 F_4 progenies of wheat.

F_4 Progenies	Seed index (100 seed weight)				Grain yield per plant			
	Cv	Vg	h^2	GA	Cv	Vg	h^2	GA
Bhittai x IB -25/99	7.35	0.01	5.95	0.04	36.69	--	--	--
Soghat-90 x Sarsabz	9.36	0.05	43.59	0.31	35.92	11.84	45.16	4.77
Marvi-2000 x Soghat-90	15.34	0.24	69.12	0.83	49.07	38.26	70.54	10.70
Khirmanx RWM-9313	5.08	--	--	--	41.98	58.05	60.25	12.17
Khirman x Kiran-95	8.55	0.02	20.51	0.14	55.24	11.03	36.23	4.11
RWM-9313 x Kiran-95	6.42	0.01	14.87	0.08	55.44	3.64	13.48	1.45
Marvi-2000 x Khirman	6.81	--	--	--	31.38	--	--	--

Heritability (h^2 b.s) for most of the traits was considerably high indicating that the traits are more amenable to selection and could be improved easily by simple selection. However these hybrids failed to show higher values of genetic advance. Higher heritability associated with low genetic advance for these traits is probably due to nonadditive gene (dominance and epistasis) effects (Sharma & Tyagi, 1991). The relay of genetic gain and large heritability value depends upon the genetic constitution of the varieties involved in the cross (Malik *et al*., 1988).

The high heritability values obtained in the hybrids for different characters offers the scope of selection in the population with respect to these traits, whereas, high coefficient of variability and genetic variance reflects the amount of variation and the chance of selection (Rajper *et al.,* 1998). Heritability estimates reported by Karaivanov & Kostova (1983), Krayljevic (1986), Molotkov (1990), Nanda *et al*., (1982), Olivero Camargo (1989) and Rehman & Kronstad (1992) indicate that certain components of grain yield in wheat are more heritable than others.

It has been observed from this study that the different segregating cross progenies had different pattern of inheritance for grain yield and its contributing traits. Two progenies Marvi-2000 x Soghat-90 and Marvi-2000 x Khirman had proven to be the best combiners for genetic parameters along with metric traits. The selection for desirable characters can be made by selecting individual plant populations from these estimated good progenies.

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