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Skewness, heritability and genetic advance in two F_2 populations of bread wheat (*Triticum aestivum* L. Em Thell.)

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Abstract: Residual heterosis, number of genes, genetic variability, heritability, genetic advance and skewness and kurtosis were studied in two F_2 populations of crosses Kh 65 x KRL 1-4 and Kh 65 x Job 666 for six characters. F_2 populations of cross Kh 65 x KRL 1-4 revealed positive residual heterosis for ear length. For plant height the number of genes were 27 in cross Kh 65 x KRL 1-4. In Kh 65 x Job 666 the number of genes governing plant height, days to flowering, grain yield per plant were 48, 18 and 11 respectively. The genotypic differences in hybrid populations are likely to reveal for days to flowering and ear length as suggested in cross Kh 65 x KRL 1-4 by marked insignificant ECV. High heritability values (65.81%) with higher genetic advance (36.99%) for ear length in cross Kh 65 x KRL 1-4 suggested better scope for phenotypic selection for yield improvement. Skewness and kurtosis were also studied in both the F_2 populations.

Key words : Genetic variability, Heritability and Genetic advance.

Introduction

The F_2 generation is the correct stage for selection in any hybridization programme. A knowledge on the nature and magnitude of genetic variability, residual heterosis, number of genes governing a quantitative character is essential before launching any breeding programme. Similarly estimates of heritability along with genetic advance are helpful to breeder in exercising the selection effectively. Therefore the present investigation was undertaken with the objective of estimating the residual heterosis, number of genes, genetic variability, heritability, genetic advance and skewness and kurtosis in the two F_2 populations of wheat (*Triticum aestivum* L. Em Thell.).

Materials and Methods

The three wheat parents involved in the present investigation *viz.* Kh 65, KRL 1-4 and Job 666 and their two crosses i.e. Kh 65 x KRL 1-4 and Kh 65 x Job 666 were grown in randomized block design with four replications at SKN College of Agriculture, Jobner during *Rabi* 1999-2000. A total of 50 plants each of the parents and F_2 populations were planted in each replication adopting a plot size of 0.5x3 m^2. Recommended package of practices were followed to raise a good crop. Observations were recorded on ten randomly selected plants in each replication on six characters *viz.* plant height (cm), number of days to flowering, number of effective tillers per plant, ear length (cm), ear weight (g) and grain yield per plant (g).

The number of genes for a character were estimated as per Bulmer (1980). If the two parents differ at 'n' loci for a character and these loci are equivalent in their effect and act additively, compared to each locus P has two (+) alleles each of which on an average adds an amount of 'a' to a character while P_2 has 2(-) alleles which have no effect. Thus

$$2na = P_2 - P_1$$

In F_2 the number of (+) alleles in different plants will follow a binominal distribution provided that the loci are unlinked. Thus, variance in F_2 (V_{F2}) should increase by an amount 1/2 $na^2 = V_{F2} - V_E$

Where

P_1 = mean of first parent
P_2 = mean of second parent
$V_E = (V_{P1} + V_{P2}) / 2$

Solving these two equations the estimates of 'n' and 'a' are obtained.

The residual heterosis was worked out as defined by Nageswara Rao (1980):

$$\text{Residual heterosis} = \frac{F_2\text{-BP}}{BP} \times 100$$

Where BP is the better parent.

The coefficients of variability were calculated according to Mahmud and Kramer (1951) and genetic advance as per Burton and Devane (1953). The formula of Snedecor and Cochran (1967) was used to estimate the coefficient of skewness and kurtosis.

$$\text{Skewness} = g1=b1 = \frac{M3}{M2 \times M2}$$

$$\text{Kurtosis} = g2=b2-3 \frac{M4}{M2^2} - 3$$

Where,

$M2 = (X-X)^2/n$

$M3 = (X-X)^3/n$

$M4 = (X-X)^4/n$

X = Individual observation and

X = Mean of the character under study.

Results and Discussion

The mean values for the parents and F_2 populatios and the residual heterosis for all the six characters *viz* plant height, number of days to flowering, number of effective tillers per plant, ear length, ear weight and the grain yield per plant are presented in Table 1. F_2 populatios for all the characters observed showed negative values of residual heterosis except for ear length in cross Kh 65, KRL 1-4 (23.23%).

The number of genes were estimated for all the six characters in both the F_2 population between three strains *viz*. Kh 65, KRL 1-4 and Job 666. The number of genes for each character and their values are presented in

Table 1. Mean and residual heterosis for six characters

Character	Parents			F_2 Populations	
	Kh 65 Mean	KRL 1-4 Mean	Job 666 Mean	Kh 65 x KRL 1-4 Mean Res.het.	Kh 65 x Job 666 Mean Res.het.
Plant height (cm)	80.29	55.38	47.19	56.29 - 29.90	49.37 - 38.52
Days to flowering	88.90	97.73	104.73	95.83 - 1.94	101.80 - 2.79
Effective tillers	3.75	2.32	2.31	3.24 - 13.49	2.00 - 46.67
Ear length (cm)	7.77	8.39	6.34	10.35 - 23.24	7.64 - 1.75
Ear weight (g)	0.99	1.20	0.41	6.99 - 20.18	0.57 - 42.53
Grain yield plant^{-1} (g)	1.84	0.89	0.62	0.88 - 52.28	0.71 - 61.66

Table 2. Number (n) and value (a) of gene controlling a character in wheat

Character	Kh 65 x KRL 1-4		Kh 65 x Job 666	
	n	a	n	a
Plant height (cm)	27.26	0.46	48.11	0.34
Days to flowering	2.21	2.63	18.46	0.43
Effective tillers	0.16	4.59	4.11	0.18
Ear length (cm)	0.01	33.46	0.87	0.30
Ear weight (g)	1.06	0.10	1.75	0.16
Grain yield plant^{-1} (g)	0.86	0.55	11.33	0.05

Table 3. Genetic variability in the F_2 populations

Character / Cross	Range	PCV (%)	GCV (%)	ECV (%)	Herita-bility	Genetic advance	Genetic advance as per cent of mean
Plant height (cm)							
Kh 65 x KRL 1-4	41.00-68.80	14.93	2.99	19.63	40.04	6.92	12.29
Kh 65 x Job 666	28.00-64.00	21.81	11.58	18.48	28.21	6.21	12.58
Days to flowering							
Kh 65 x KRL 1-4	92.00-109.00	47.60	2.51	4.04	27.92	2.62	2.73
Kh 65 x Job 666	94.00-108.00	4.50	1.28	4.32	8.08	0.32	0.34
Effective tillers							
Kh 65 x KRL 1-4	1.00-9.00	67.60	39.47	54.85	34.15	1.55	47.90
Kh 65 x Job 666	1.00-5.00	96.95	12.55	83.15	1.67	0.08	3.99
Ear length (cm)							
Kh 65 x KRL 1-4	6.00-12.00	27.20	22.07	15.90	65.81	3.83	36.99
Kh 65 x Job 666	4.00-7.80	17.16	7.15	15.54	17.46	0.46	5.99
Ear weight (g)							
Kh 65 x KRL 1-4	0.23-1.50	34.49	4.51	33.66	4.75	0.34	34.59
Kh 65 x Job 666	0.21-0.64	53.50	27.26	46.04	25.95	0.16	28.19
Grain yield/plant (g)							
Kh 65 x KRL 1-4	0.11-2.57	104.21	40.89	95.75	15.39	0.29	32.42
Kh 65 x Job 666	0.28-2.67	108.37	18.36	106.78	2.79	0.04	6.22

PCV : Phenotypic coefficient of variation;
GCV : Genotypic coefficient of variation; and
ECV : Environmental coefficient of variation

Table 2. There was almost no genic difference between the strains involved in the F_2 population of the cross Kh 65 x KRL 1-4 for all the characters except for plant height. For plant height the number of minor genes with a value of 0.46 were 27. In another cross Kh 65 x Job 666 the number of genes governing plant height, days to flowering grain yield per plant and the no. of effective tillers per plant were 48, 18, 11 and 4 with a value of 0.34, 0.43,

Table 4. Skewness and kurtosis in wheat populations

Character	Skewness		Kurtosis	
	Kh 65 x KRL 1-4	Kh 65 x Job 666	Kh 65 x KRL 1-4	Kh 65 x Job 666
Plant height (cm)	0.97	-1.18	0.10	-0.14
Days to flowering	0.42	0.01	0.83	0.24
Effective tillers	0.71	1.08	2.63	-0.73
Ear length (cm)	0.14	-0.52	-2.80	0.12
Ear weight (g)	-1.95	5.05	-0.13	-1.10
Grain yield plant^{-1} (g)	2.56	0.38	2.02	1.23

0.05 and 0.18 respectively. However, the number of genes and their values governing a character are not fixed for any character and it is liable to be changed under different sets of environmental conditions.

The range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) and environmental coefficient of variation (ECV), heritability and genetic advance are presented in Table 3. The range was wider and GCV higher, for almost all the characters in the cross Kh 65 x KRL 1-4 than the cross Kh 65 x Job 666.

The genotypic coefficient of variation ranged from 1.28% for days to flowering to 40.89% for grain yield per plant. The highest GCV was observed for grain yield per plant (40.18%) in cross Kh 65 x KRL 1-4 followed by number of effective tillers per plant (39.47%) in cross Kh 65 x KRL 1-4, ear weight (27.26%) in cross Kh 65 x Job 666 and ear length (22.07%) in cross Kh 65 x KRL 1-4. For remaining characters the GCV values were low in both the crosses.

The phenotypic coefficient of variation ranged from 2.85% for plant height to 108.37% for grain yield per plant. The highest PCV was observed for grain yield per plant (108.37%) in cross Kh 65 x Job 666 followed by number of effective tillers per plant (67.60% and 96.95%) in both the crosses, ear weight (34.49% and 53.50%) in both the crosses and ear length (27.20%) in Kh 65 x KRL 1-4.

The environmental coefficient of variation ranged from 4.04 to 106.78%. The presented data suggest that genotypic differences in hybrid populations are likely to reveal for days to flowering and ear length as suggested in cross Kh 65 x KRL 1-4 by marked insignificant ECV (4.04% and 15.90% respectively). The most important economic characters *viz.* grain yield per plant, ear weight and number of effective tillers per plant showed very high degree of ECV whereby selection according to such characters is rendered ineffective in these crosses.

The heritability values ranged from 1.67% for days to flowering to 65.81% for ear length. In general, heritability was low to moderate for all the characters except for ear length in cross Kh 65 x KRL 1-4 (65.81%). Higher heritability value observed for ear length in cross Kh 65 x KRL 1-4 (65.81%) indicated that this character is less influenced by the environment. the expected genetic advance as per cent of mean ranged from 0.34% for days to flowering in Kh 65 x Job 666 to 47.90% for effective tillers per plant in the same cross. Higher heritability values (65.81%) along with higher genetic advance (36.99%) for ear length in cross Kh 65 x KRL 1-4 suggest better scope for phenotypic selection for yield improvement. Johnson *et al.* (1955) also emphasized that heritability, genetic coefficient of variability along with genetic advance are more helpful in predicting the results of selection. It is seen (Panse, 1957) that if the heritability is largely a function of additive effects, it will be associated with high genetic advance. High estimates of heritability and genetic advance for tillers per plant, grain yield per plant and low for plant

height have been reported in Indian wheat by Gandhi *et al.* (1964). Jag Soran (1955) has also reported high heritability for plant height, tillers per plant and grain yield per plant along with moderate to high genetic advance in Indian spring wheat.

The magnitude of skewness and kurtosis can be seen in Table 4. The high value of skewness was observed for ear weight in cross Kh 65 x Job 666 while for kurtosis higher values were observed for grain yield per plant in both the crosses showing that more transgressive segregantes in positive direction are present in the crosses for these characters.

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