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Heritability of Various Morphological Traits in Wheat

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ABSTRACT

F_2 population of six cross combinations namely WLRG-3 x LU26S, WLRG-3 x 5039, WLRG-4 x 5039, WLRG-5 x 5039, WLRG-6 x 5039, WLRG-6 x LU26S involving six wheat varieties/lines was studied to determine the broad-sense heritability and genetic advance for plant height, number of tillers per plant, flag leaf area, peduncle length and grain yield per plant. The broad-sense heritability values for plant height and number of tillers per plant ranged from 49.83 to 88.83 and 52.25 to 88.82%, respectively, while these heritability estimates ranged from 66.31 to 85.01 and 47.72 to 84.59% for flag leaf area and peduncle length, respectively. The broad-sense heritability for grain yield per plant ranged from 65.58 to 90.01%. The genetic advance values for plant height, number of tillers per plant, flag leaf area, peduncle length and grain yield per plant ranged from 6.30 to 19.88, 1.87 to 4.42, 4.78 to 10.10, 2.68 to 10.38 and 4.95 to 11.61, respectively. The cross WLRG-3 x 5039 appeared to be the most promising segregating material for selecting high yielding wheat genotypes.

Key Words: Wheat; F_2 population; Broad-sense heritability; Genetic advance; Grain yield; Morphological traits

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important and widely adapted food cereal of Pakistan. It is the major human consumable commodity in most areas of the world including Pakistan. The annual area under wheat crop is 7983 (000) ha with grain production of 18475 (000) tons and average yield of 2314 kg ha^{-1} (Govt. of Pakistan, 2002). Hybridization is one of the main tools to produce genetic variability. Selection provides an opportunity for carrying out any breeding program effectively. Broader the range of heritable variation more effective will be the selection and vice versa. The practical knowledge of mechanisms of inheritance of the genetic traits involved, occupies key post in the process of progress towards desired end in the form of enhanced yield.

Heritability measures the phenotypic variance, which is attributable to genetic cause. The concept of heritability is associated with the relative influence of heredity and environment. It indicates the structure of population and the extent to which a given character would be transmitted to the next generation. The knowledge of heritability helps the plant breeder in predicting the behaviour of the succeeding generation and making desirable selections. The higher the heritability, simpler will be the selection process and greater will be the response to selection. Heritability estimates presented in this research work will enable us to make predictions about the possible progress that can be achieved by making the selection more effective. The present studies were, therefore, designed to estimate the extent of the heritability of some morphological yield related characters. Kisana *et al*. (1982) studied broad sense heritability and genetic advance in five crosses of wheat and obtained high heritability for plant height in all crosses. Chaudhry *et al*. (1984) analyzed eight single crosses between 13 wheat varieties and advanced lines to ascertain inheritance pattern, broad sense heritability and genetic advance for tillers per plant, plant height, peduncle length, spike length and grain yield per plant. All the characters studied were quantitatively inherited and heritability estimates for the different characters were generally moderate to high in all the crosses with genetic advance ranging from 2.69 to 7.12. Das and Rehman (1984) studied 8 quantitative traits in 9 varieties of wheat and observed a wide genotypic and phenotypic variability for plant height. Heritability value was also high for this trait. Raut *et al*. (1996) studied genetic variability in 32 genotypes of wheat. Peduncle length exhibited high estimates of heritability accompanied with high genetic advance. Chowdhry *et al*. (1997) computed the broad-sense heritability and genetic advance value for yield components involving six bread wheat crosses. Moderate to high heritabilities were observed for plant height, spike length and grain yield per plant with high genetic advance values, but moderate heritability and high genetic advance values were observed for flag leaf area. Ghimiaray and Sarkar (2000) estimated heritability (broad sense) and genetic advance in wheat. High heritability coupled with genetic advance was recorded for number of tillers per plant.

MATERIALS AND METHODS

The present study was conducted in the experimental area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad during Rabi season 2001-2002. The experimental material comprised of crosses involving six lines/strains of wheat as parents viz; LU26S, 5039, WLRG-3, WLRG-4, WLRG-5 and WLRG-6. The crosses include WLRG-3 x LU26S, WLRG-3 x 5039, WLRG-4 x 5039, WLRG-5 x 5039, WLRG-6 x 5039 and WLRG-6 x LU26S. The F_2 seeds were spaced planted in lines with the help of a dibble keeping plant to plant 15 and

row to row distance of 30 cm. At maturity, 200 competitive plants from F_2 population of each cross and 20 plants from each parent were taken for recording of data for plant height (cm), number of tillers per plant, flag leaf area (cm^2), peduncle length (cm), and grain yield per plant (g). However, the flag leaf area was measured when the leaves were fully developed and green before maturity.

Heritability in broad sense was calculated according to Mahmud and Kramer (1951).

$$h^2(B.S.) = \frac{VF_2 - \sqrt{VP_1 \times VP_2} \times 100}{VF_2}$$

Where,

VF_2 = variance of F_2.
VP_1 = variance of parent 1.
VP_2 = variance of parent 2.
$h^2(B.S)$ = broad sense heritability.

Genetic advance was calculated following Allard (1960) as under:

$$GA = \sigma_P \times h^2 \times i$$

Where,

σ_P = standard deviation of phenotypic variance
h^2 = broad sense heritability in fraction.
i = selection intensity.

(The value for i = 1.755 in this study at 10% selection pressure)

RESULTS AND DISCUSSION

The estimates of mean, variance, coefficient of variability are presented in Table I and heritability and genetic advance in Table II for various traits of F_2 population. Results of the present study generally agree with those of Chaudhry *et al*. (1984), Chowdhry *et al*. (1997), Das and Rehman (1984), Ghimiaray and Sarkar (2000) and Raut *et al.* (1996) and suggest that plant height, number of tillers, flag leaf area, peduncle length, and grain yield behaved as quantitatively inherited characters: their F_2 distributions though skewed to varying degrees in different crosses, followed a continuous pattern. There occurred considerable increase in variation and coefficient of variability for the traits under study in F_2 populations from their respective parents (Table I) and thus appeared as source for providing opportunity to beneficial selection.

It is evident from the Table I that cross WLRG-3 x LU26S had highest value of variance (161.81) and coefficient of variation (12.38) for plant height; while lowest variance and coefficient of variation was noted in WLRG-6 x 5039 for the same trait. Among parents WLRG-4 showed highest value of variance (54.05) and coefficient of variation (8.31), while lowest value of variance (12.4) and coefficient of variation (3.31) was noticed in 5039 for plant height. In the six F_2 populations studied, mean plant height ranged from 102 (WLRG-3 x LU26S) to 119.82 cm (WLRG-5 x 5039); whereas, the parents averaged 88.50 (WLRG4) and 108.41 cm (WLRG5). The F_2 means for plant height deviated considerably from the mean of the

Table I. Means, Variances and coefficients of variability for some morphological traits in wheat

Genotypes/Characters	Plant height (cm)			Flag leaf area (cm^2)			Number of tillers/ plant			Peduncle length (cm)			Grain yield/plant (g)		
	$\bar{X}$	δ^2	CV	$\bar{X}$	δ^2	CV	$\bar{X}$	δ^2	CV	$\bar{X}$	δ^2	CV	$\bar{X}$	δ^2	CV
Parents															
WLRG-3	98.1	15.7	4.0	23.1	7.8	12.1	12.2	3.1	14.4	36.6	4.5	5.8	16.4	13.0	22.0
WLRG-4	88.5	54.1	8.3	26.3	7.3	10.3	10.7	0.7	7.7	34.8	16.4	11.6	12.2	12.1	28.5
WLRG-5	108.4	22.1	4.3	30.3	5.8	10.0	13.4	1.2	8.0	37.4	11.3	9.0	19.1	7.1	13.0
WLRG-6	96.2	30.0	5.7	22.1	15.4	17.7	12.2	1.3	9.3	36.2	7.6	7.6	15.6	6.6	16.5
LU-26S	107.2	20.9	4.3	19.7	4.1	10.3	10.8	0.6	7.3	38.1	5.3	6.0	19.1	1.5	6.4
5039	106.3	12.4	3.3	25.7	6.0	9.5	13.2	1.3	8.6	41.4	5.0	5.4	18.6	6.1	13.3
F_2 Populations															
WLRG-3 x LU-26S	102.8	161.8	12.4	24.8	16.8	16.5	10.1	5.5	23.3	41.8	30.3	13.2	20.6	36.4	29.4
WLRG-6 x LU-26S	119.4	71.4	7.1	24.5	37.0	24.9	11.7	8.0	24.2	45.1	20.3	10.0	16.3	31.4	34.3
WLRG-3 x 5039	107.6	46.3	6.3	31.4	45.6	21.5	11.2	4.2	18.2	43.1	9.4	7.1	22.8	49.8	31.0
WLRG-4 x 5039	105.5	51.7	6.8	29.1	20.3	15.5	10.9	6.8	23.8	35.4	23.2	13.6	19.8	59.4	38.9
WLRG-5 x 5039	119.8	147.3	10.1	23.7	18.0	17.9	12.3	6.3	23.6	40.5	48.7	17.2	19.3	31.2	29.0
WLRG-6 x 5039	107.4	43.1	6.1	25.5	31.0	21.8	12.3	5.1	18.4	42.5	11.8	8.1	21.9	18.4	19.6

Table II. Heritability %ages and genetic advance for some morphological traits in wheat

F_2 Populations/ Characters	Plant height		Flag leaf area		Number of tillers/ plant		Peduncle length		Grain yield/plant	
	h^2	GA	h^2	GA	h^2	GA	h^2	GA	h^2	GA
WLRG-3 x LU-26S	88.8	19.9	66.3	4.8	75.1	3.1	83.9	8.1	87.9	9.3
WLRG-6 x LU-26S	64.8	9.7	48.5	8.4	88.8	4.4	68.9	5.5	90.0	8.9
WLRG-3 x 5039	69.9	8.4	85.0	10.1	52.3	1.8	49.7	2.7	82.1	10.2
WLRG-4 x 5039	49.8	6.3	67.2	5.3	86.2	3.9	61.0	5.2	85.6	11.6
WLRG-5 x 5039	88.8	19.0	67.2	5.0	80.7	3.6	84.6	10.4	78.9	7.7
WLRG-6 x 5039	55.3	6.4	68.9	6.7	74.8	3.0	47.7	2.9	65.6	5.0

respective parents, remained mostly within the parental range, but in some cases it was higher than their respective parents. It is apparent from this situation that different genotypes of desired height level could be effectively selected from this material.

Flag leaf area plays a vital role in proper grain filling and development. It appeared to be highly variable trait with high values of heritability i.e., 85% and genetic advance (10.10) for cross combination WLRG3 x 5039 (Table II), which suggested that effective and proper selection for this trait is possible. These results are in agreement to the work of other research workers like, Chaudhry *et al*. (1984), Chowdhry *et al*. (1997), and Das and Rehman (1984).

The F_2 means for number of tillers per plant and peduncle length showed deviation from their respective parents, but remained mostly within the parental range.

The F_2 distribution for grain yield after plant height, showed a greater positive skewness than the other characters. The F_2 population of cross combination WLRG3 x 5039 produced 22.78 g plant^{-1} and have high genetic advance. Thus, it appeared that selection would be effective for excellent improvement of this character. The evidence for heterotic effects for grain yield is provided by the F_2 means, which closely approached the mean of the better parents (Table I). These results agree with those of Chowdhry *et al*. (1997), Das and Rehman (1984), Ghimiaray and Sarkar (2000) and Raut *et al.* (1996)

However, it should be noted that since the heritabilities reported are based on single plant selections from the F_2's, these estimates can not be justly used in predicting gains from selections when the unit of selection is other than the single plant. Transgressive segregation for these characters also occurred to a variable degree in most of the crosses. The frequency of such segregates suggests that desirable gene combinations occurred in these populations and selection may be advantageous.

CONCLUSION

From the estimates of heritability it appeared that cross combination WLRG-3 x 5039 possesses high heritability for number of tillers, and grain yield per plant. Thus, it is suggested that the cross WLRG-3 x 5039 should be given due importance in further breeding program. Moreover, selection for number of tillers per plant and flag leaf area is suggested to improve the yield.

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