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HERITABILITY STUDIES OF YIELD AND YIELD ASSOCIATED TRAITS IN BREAD WHEAT

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Abstract

Heritability studies provide valid information about the traits that are transmitted from parents to offspring and also to the successive generations. Such studies help plant breeders to predict a successful cross with high heritability transmission to the progeny and thus are useful in the incorporation of characters into the offspring. Heritability study was conducted in F_5 segregating generation of a cross between HT5 (female) and HT 37 (male) of bread wheat. The genetic parameters calculated were genetic variance (Vg,), environmental variance (Ve) and heritability percentage in broad sense (h^2%), genetic advance (GA) and heritability coefficient (H). The highest heritability was observed for spike length (79.3%), number of grains per spike (54.5%) and main spike yield (69.5%) associated with high genetic advance (2.8, 22.8 and 1.5 respectively). Moderate to high heritability were recorded for peduncle length (48.75%) and number of grains per spikelet (47.2%) which associated with high genetic advance (2.3 and 0.68 respectively). However awn length and plant height had shown acceptable heritability values. The present finding suggests that most of the yield associated traits have been successfully transmitted. The information generated will be helpful for better understanding and selection of suitable, desirable material especially in advance generations.

Introduction

Wheat has become an important cereal crop from all perspectives. It provides more calories in diet than any other crop. It is staple food crop and also known as “king” of the cereals. Wheat is grown in Pakistan over an area of 8578 hectares with the production of 23295 tons (Anon., 2007). Due to ever increasing population, the demand of wheat is increasing day by day. Competition among existing and advance lines has also increased. There is need for effective and quick selection of wheat strains that could possess desired traits. High value of heritability and predicted genetic advance clarifies that the selection among genotype would be effective for yield and yield components (Ghandorah & Shawaf, 1993). High heritability (broad sense) associated with high genetic advance reveals strong contribution of additive genetic variance for expression of the traits and the selection based on these traits could play a vital role in improving grain yield (Iqbal & Khan, 2003). The studies conducted by various researchers have shown that high heritability alone is not enough for selection in advance generations; it must be accompanied with substantial amount of genetic advance (Memon *et al*., 2007; Mangi *et al*., 2008). However, if a character or trait is controlled by non additive gene action it gives high heritability but low genetic advance, while the character ruled by additive gene action, heritability and genetic advance both would be high (Ahmed *et al*., 2007).

The study of statistical parameters like mean, variance, habitability and genetic advance is a measure to evaluate genetic stability and performance of any genotype for effective selection of particular traits in that genotype (Firouzian, 2003). Main quantitive traits associated with high heritability and high genetic advance has great importance in selection of genotype in early generations (Memon *et al*., 2005). Heritability values can be used as a measuring scale to determine genetic relationship between parents and progeny (Memon *et al*., 2007). Better heritability values recorded points to the possibility of improvement in the parameters therefore attention may be focused on important traits while synthesizing genotypes (Ahmed *et al*., 2007). Yield is a polygenic trait and attributed to its associated trait therefore for the higher yield the total genetic expression of all its component genes is needed. However their expression is also influenced by environmental factors (Sial *et al*., 2003). Heritability and genetic advance enables the breeders to use best genetic stock for improving the crop (Mangi *et al*., 2008). The success of any breeding programme depends upon amount of genetic diversity existing in germplasm and it is pre-requisite to have a good knowledge of heritability and genetic advance present in different yield associated parameters (Waqar-ul Haq *et al*., 2008). Rambaugh *et al*., (1984) described that heritability study must be conducted in favorable environments rather than unfavourable environments; genetic parameters such as mean, genetic variance, broad sense heritability and genetic advance are decreased under unfavorable environments.

Material and Methods

The segregating material (F_5 progeny) from a cross between two high yielding exotic genotypes endowed with desired traits (longer spike bold seed and more number of grains) were evaluated for a cross which was made between female HT5 and male HT37. The experiment was conducted at Nuclear Institute of Agriculture (NIA) Tando Jam. The experiment had 10 rows of 5 meter length of each parental line along with their respective segregating generation. At maturity ten plants from each parental line and offspring were randomly selected and tagged. Data on plant height, spike length, number of grains per spike, number of grains per spikelet, spikelet per spike, main spike grain yield, awn length and node per plant was recorded for selected plants of parental lines and segregating generation. Grains per spikelet were calculated by dividing number of grains per spike with the number of spikelets per spike. Plant height was recorded from ground level up to terminal end of spike excluding awns. All agronomical practices such as weeding, rouging were performed as usual for parental lines and offsprings and all were equally treated. Genotypic variance, environmental variance, heritability percentage in broad sense, heritability coefficient were calculated as suggested by Falconer (1977). The legends of the formula shown by Larik *et al*., 1989 is as follows:

$$\text{Coefficient of variability (CV)} = \frac{\text{s.d x } 100}{X}$$

Genetic variance (Vg) = VF_5 - Ve
Environmental variance (Ve) = $(VP_1 + VP_2)/2$

$$h^2 \quad \frac{VF_5 - (VP_1+VP_2)/2}{VF_5} \text{ X } 100$$

where, V = variance, F_5 = fifth 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
Genetic advance (GA) = K x (H) x SD

Results and Discussion

As the male parent was earlier in ear emergence and maturity while the female parent was later in heading and also had late maturity period. HT5 (male parent) was taller in height (120-130cm) than the HT37 (female parent) which had semi-dwarf height (80-90cm) whereas male parent had longer and thick spike than the female. Male parent had 1000 grain weight 32-35g while female parent produced 1000 grain weight in the range of 35-38g. The objective to make cross between these genotypes was to transfer the early heading with early maturity and longer thick spike with more number of grains in segregating population. Number of crosses were made to incorporate such desired traits. We ultimately successded to transfer these traits in the cross progeny which was confirmed in advance generation (F_5) through the help of this study. The early heading, early maturing semi-dwarf (104.4cm) hybrid plants with very long thick spike (15.43cm) and more number of bold grains (86.8 grains) having 1000 grain weight in range of 47-49g have been obtained in cross progeny. It is very surprising that both parents have contributed their desired traits to progeny. Mean performance of characters studied in F_5 segregating generation and their respective parents is given in Table 1.

The cross progeny has shown outstanding performance over its parents for most of the traits. Hybrid plants produced 3.8g main spike grain yield showing significant increase over both the female and the male parents main spike grain yield 2.24g and 2.74g respectively. Number of grains per spike is an important component of yield so any change in grain number will ultimately affect yield (Rajaram *et al*., 1996). Mean number of grains per spike in the male parent was found 73.4 and in female parent was 66.4 grains; while offspring has produced significantly higher number of 86.8 grains per spike. Spike length is a character of considerable importance as the larger spike is likely to produce more grains and eventually the higher yield (Ahmed *et al.,* 2007; Sheikh *et al*., 2000). Cross progeny has also maintained its superiority over both the parents in number of spikelets per spike, spike length and in number of grains per spikelet. Hybrid produced 15.43cm longer thick spike having 24.8 spikelets per spike. However no significant increase was recorded in offspring for the character of plant height, number of nodes per plant and in peduncle length (Table 1).

The genetic parameters like genetic variance, environmental variance, heritability in broad sense and genetic advance is shown in Table 2. The highest heritability was observed for spike length (79.35%) followed by main spike yield (69.55%), and number of grains per spike (54.5%); this high heritability was also associated with greater genetic advance for above traits. Genetic advance for spike length, main spike yield, number of grains per spike was higher (2.86, 1.54 and 22.88, respectively). Moderate to high heritability was recorded for peduncle length (48.75%) and number of grains per spikelet (47.24%). These were also associated with high genetic advance (2.33 and 0.68 respectively).whereas awn length and plant height had shown acceptable heritability values. These findings indicated that most of the yield associated genetic parameters have been successfully transmitted to the successive generations from the parents. (Table 2). This suggests that transmission of these characters in this cross has successfully occurred and could be a valuable cross for the particular traits. These results will be helpful in predicting the suitable parental lines for further breeding programme.

Table 1. Overall mean of yield and yield associated traits of F_5 segregants/variants and their parental lines.

Parents/Cross	Plant height (cm)	Spike length (cm)	Spikelets/ spike	Grains/ spike	Grains/ spikelet	Main spike yield (g)	Peduncle length (cm)	Awn length (cm)	Nodes per plant
HT 5 (female)	103.8	10.37	21.6	73.4	3.38	2.24	39.3	5.52	4.2
HT 37 (male)	120.3	11.66	19.6	66.4	3.36	2.74	45.7	7.88	4.7
HT5 ♀ x ♂HT 37	104.4	15.43	24.8	86.8	3.48	3.8	41.1	8.6	4.0

Table 2. Genetic variance (Vg), environmental variance (Ve), heritability percentage (h^2%) in broad sense, heritability coefficient (H), genetic advance (G.A) for different characters studied in F_5 generation of wheat.

Character studied	Genetic variance Vg	Environmental variance Ve	Heritability percentage (h^2%)	Heritability coefficient (H)	Genetic advance (G.A)
Plant height	1.21	17.28	6.54	0.065	0.58
Spike length	2.46	0.64	79.35	0.79	2.86
Spikelet/spike	-1.42	2.71	-110.4	-1.10	2.56-9
Grains/spike	230.69	192.59	54.50	0.54	22.88
Grains/spikelet	0.24	0.268	47.24	0.47	0.68
Main spike yield	0.804	0.352	69.55	0.69	1.54
Peduncle length	2.73	2.87	48.75	0.48	2.33
Nodes/plant	-	-	-	-	-
Awn length	0.07	0.205	25.45	0.25	0.26

High heritability in wheat has been observed by various researchers for spikelet per spike (Prodanovic 1993; Dechev, 1995). Saleem *et al.,* (2003) recorded high heritability ranging from 58.4 to 79.1 and genetic advance ranging from 1.8 to 2.82 for spikelet per spike. Similarly high heritability for grain yield was noted by Chowdhry *et al*., (1997) and Ozkan *et al*., (1997). Waqar-ul-haq et *al*., (2008) had observed almost similar results as these findings. They tested ten wheat genotypes and studied spike length, spikelet per spike, number of grains per spike, grain yield per plant and 1000 grain weight and observed high heritability and genetic advance for yield and yield associated traits. From the present study it is clear that sufficient variation for number of grains per spike, spike length and spikelet per spike is present in F_5 generation of this population therefore effective selection for these traits should be practiced for further improvement of cross progeny.

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