
RESEARCH ARTICLE

Estimation of heritability for production traits in bread wheat under rainfed condition

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Abstract

Thirty-six wheat lines including check cultivar Pir Sabak-15 were evaluated under climatic conditions of Peshawar, Pakistan, during 2020-21. The experiment was laid out in Randomized complete block design with three replications. Analysis of variance revealed significant differences among the genotypes for all studied traits except tillers m⁻². Heritability estimates were lowest for tillers m⁻² while, highest for days to heading. High heritability was observed for days to heading while moderate heritability was observed for flag leaf area, plant height, spike length, 100-grain weight, biological yield and harvest index. The highest grain yield was produced by G-34, G-11 and G-9 followed by G-5, G-11, G-2, G-27, G-33, G-4, G-35, and G-36. Tillers m⁻², flag leaf area, plant height, spike length and biological yield showed positive and significant association with grain yield. These results suggest that all the traits showing significant correlation with grain yield which needs better attention in future wheat breeding programs for increasing yield.

Key words: Heritability, bread wheat, correlation, yield, rainfed

Introduction

Wheat is cultivated widely across almost all

around the world, which represent about 30% of the cereal cultivation area, and provides 20% of the calories for the human population (Khan *et al.*, 2015. Ahmed *et al.*, 2017). It is the prime and important staple food of the inhabitants of Pakistan and most of the developing countries. During 2019, the area under wheat cultivation in world was 215.9 million hectare having total production of 765.7 million tons while in Pakistan, the area under wheat cultivation was 8.6 million hectare having total production of 24.3 million tons (FAOSTAT, 2019). In Khyber Pakhtunkhwa province, it was grown on 0.73 million hectares which produced 1.13 million tons with an average yield of 1554 kg ha⁻¹. In order to compete in the international market, we must focus and concentrate on the nutritional quality of wheat grain before export (Ijaz *et al.*, 2013). Likewise, around 67% wheat area is planted as rainfed crop in the province (KP). Farmers plant wheat in winter (Oct-Nov) with hope that rainfall occurs, with few to wait for rain to moist fields for wheat sowing in the season, which caused a considerable delay in wheat sowing in the season resulted in lower yield. Appropriate variety selection for the rainfed region is major issue in Pakistan and in KP particularly (Naz and Akmal, 2016). Sufficient availability of water for crops during growth and development,

therefore, directly correlate with future food security in the region (Iqtidar *et al.*, 2006). Heritability estimates provide authentic information about the extent to which a particular genetic trait is transmitted to the successive generation. Heritability can be defined as, the proportion of phenotypic variance attributable to genetic variance or heritability is the extent to which genetic individual differences contributes to individual differences to observed behavior (or phenotypic individual differences). Heritability estimates provide a message that how much a character is controlled genetically (Mohtasham *et al.*, 2012). Genetic advance and high value of heritability predicts and clarifies if the selection is made among genotypes that would be much effective for yield and yield components (Ghandorah and Shawaf, 1993). For an effective plant improvement program, information regarding heritability estimates and genetic advance for different traits is important (Haq *et al.*, 2008). Thus, genetic advance is yet another important selection parameter that helps breeder in a selection program (Shukla *et al.*, 2004).

It is also important to obtain information about correlation of yield with other yield related characters, before the starting of any crop breeding program. Correlation studies are useful for improving yield through indirect selection of yield related traits. Correlation is a realistic technique to develop selection criteria, which is mostly based on phenotypic characters used for the improvement of yield through plant breeding program. Hence the objectives of this study was to identify high yielding wheat advanced lines under rainfed conditions, second to estimate heritability and genetic advance for yield and yield related traits as well as determine correlation among yield and its component traits.

Materials and methods

The present study was conducted to evaluate 36

wheat lines including one check to estimate heritability and genetic advance for various important plant attributes under rainfed condition in Experimental Research Farm, The University of Agriculture, Peshawar Pakistan during 2020-21 (Table 1). Plant material consisted of 36 wheat lines planted in randomized complete block design (RCBD) with three replications. Each entry consisted of four rows with row length of 3 meters and row to row space of 30cm. Standard agronomic practices were followed from the day of sowing till harvest.

Field data for various plant traits were subjected to Analysis of Variance (ANOVA) following Steel and Torie (1997). Means were separated at 5% level of probability using least significant test (LSD) upon significant differences among genotypes, heritability and genetic advance were also estimated. The heritability was categorized as low, moderate and high as given by Robinson *et al.*, (1949) where 0-30 is designated as low, 30-60 as moderate and 60 and above as high. Genetic advance is calculated as per (Shukla *et al.*, 2004) which is yet another important selection parameter that helps breeder in a selection program.

Correlation is the measure of association between two variable/traits and the value obtained is called correlation coefficient. It is symbolized as r and the value of r ranges from -1 (strong negative relationship) to +1 (strong positive relationship)

$$r_{xy} = \text{Cov}_{xy} / (V_x \cdot V_y)^{1/2}$$

+ive correlation: As variable X increases, Y variable also increase and vice versa.

-ive correlation: As variable X increases, Y variable also decreases and vice versa.

No/Zero correlation: As increase or decrease in X, does not affect Y variable and vice versa.

Results and discussion

Days to heading

The analysis of variance exhibited highly significant genetic differences among wheat genotypes for all most of all the characters (Table1). Earlier for 100-grain weight and tillers m^{-2} similar genetic differences observed by Afridi and Khalil (2007) and Farshadfar *et al.* (2014). Days to heading of wheat genotypes ranged from 100 to 109 days. (Table-2). Genetic variance for days to heading was greater (6.97) than environmental variance (2.78). Moreover, the broad sense heritability (h^2) and genetic advance for days to heading was 0.71 and 4.60. (Table 3). Rahman *et al.*, (2016) also noted high heritability and stated that days to heading is genetically controlled and must be taken into consideration. There was no significant association of days to heading with all other traits (Table 4). Rehman *et al.*, (2020) also reported that days to heading have no significant association with rest of studies traits.

Flag leaf area

Environmental variance for flag leaf area (4.65) was greater than genetic variance (3.86). The broad sense heritability (h^2) for flag leaf area was (0.45) and coupled with genetic advance of 2.73 (Table-3). Flag leaf area is considered to be the major yield contributing character due to its significant contribution in photosynthesis (Faisal and Tahir, 2014). Moreover significant positive association of flag leaf area was observed with spike length, spikelet $spike^{-1}$, grain $spike^{-1}$ and grain yield. While non-significant association with rest of traits. Uddin *et al.*, (2015) also reported significant and positive association between grain yield and flag leaf area, plant height, 1000-grain weight, and grains spike.

Tillers

Mean values for tillers m^{-2} of wheat genotypes ranged from 114 to 279. Environmental variance

for tillers m^{-2} (2937) was greater than genetic variance (272). The broad sense heritability (h^2) for tillers m^{-2} was 0.08 and genetic advance is 9.89. Kumar and Kerkhi (2015) reported moderate heritability estimates for fertile tiller. Tillers m^{-2} were significantly positively associated with plant height, biological yield, grain yield and significantly negatively associated with 100-grain weight. Gelalcha and Hanchinal (2013) also noticed significant positive association between tillers $plant^{-1}$ and spike length, grains per spike and grain yield per plant.

Plant height

Plant Height of wheat genotype ranged from 61 to 85 cm. Environmental variance for plant height (16.72) was greater than genetic variance (14.59). The broad sense heritability (h^2) for Plant Height was (0.47) coupled with genetic advance 5.37cm (Table-3). Gulnaz *et al.*, (2011) recorded high heritability and genetic advance (80%, 11.28, respectively) for plant height. Plant height was significantly positive correlated with spike length, grain yield and biological yield while it showed non-significant association with rest of the studied traits. Hussain *et al.*, (2013). Rehman *et al.*, (2015) also reported positive association between 1000-grain weight and plant height, spike length, grains $spike^{-1}$ and grain yield (Table 4).

Spike length

Least significant difference (LSD 5%) for spike length was 1.12 cm. Mangi *et al.* (2007) also reported significant difference for the spike length in F_4 wheat population. Spike length of wheat genotypes ranged from 9 to 12 cm. (Table 2). Environmental variance for spike length was greater (0.5) than genetic variance (0.4). Therefore, broad sense heritability (h^2) for spike length was (0.46) and high genetic advance was reported for spike length was (193).

Khan and Naqvi (2011) who reported high heritability and low genetic advance for spike length. Moreover significant positive association of spike length was observed with spike let spike⁻¹, grain spike⁻¹, grain weight spike⁻¹ and grain yield. While observed non-significant association of spike length was observed with remaining of the studied traits (Table 4). These results was supported by the findings of earlier researchers like Eunus *et al.*, (1986), Shah *et al.*, (1988) and Gasper and Zama (1990).

Spikelet's spike

Least significant difference (LSD 5%) for spikelets spike⁻¹ was 2.21. Selection of genotypes with more spikelets spike⁻¹ leads to increased grain yield in wheat (Mohammadi *et al.*, 2011). Significant differences were observed in all 64 wheat genotypes for spikelets spike⁻¹ are in line with the findings of Salman *et al.* (2014) and Nawaz *et al.*, (2013). Mean values for Spikelet's spikes⁻¹ ranged from 15 to 21 spikelets spike⁻¹ (Table 2). Genetic variance for spikelet's spike⁻¹ was lower (1.34) than environmental variance (1.85). Resulting in moderate (0.42) broad sense heritability (h^2) for spikelets spike⁻¹. Genetic advance for spikelets spike⁻¹ was 1.55 (Table 5). Spikelet's spike⁻¹ was significant positive correlated with grains spike⁻¹ and grain weight spike⁻¹ while it showed non-significant association with other study traits (Table 4). Our result are in contrast with Rehman *et al.*, (2020) who noted Spikelet's spike⁻¹ have no association with all other studies traits.

Grain's spike⁻¹

Significant differences were observed in all tested wheat genotypes for number of grains spike⁻¹ and are in accordance with the findings of Çifci (2012) and Baranwal *et al.* (2012). Least significant difference (LSD 5%) for grains per spike was 10.3 number of grains. Grain's spike⁻¹ among wheat genotypes ranged from 41 to 62

grains. (Table 2). Environmental variance for Grain's spike⁻¹ was greater(40.72) than genetic variance (8.63) Moreover, the broad sense heritability (h^2) for grains spike⁻¹ was 0.17 while genetic advance observed for grains spike⁻¹ was 2.53 (Table 3). Our result in contrast with Kumar *et al.* (2012) who observed low heritability for grains spike⁻¹. Grain spike⁻¹ showed positive association with grain weight spike⁻¹ while observed non-significant association with other studied traits.(Table 4). Iqbal *et al.*, (2017) who observed similar results grain spike⁻¹ showed positive and significant association with grain weight spike⁻¹.

Grain's weight spike⁻¹

Least significant difference (LSD 5%) for Grain weight per spike was 0.58g. Grains weight spike⁻¹ among wheat genotypes ranged from 2.1 to 3.25g. Environmental variance for Grain weight spike⁻¹ was greater(0.13) than genetic variance (0.03) The broad sense heritability (h^2) for grains weight spike⁻¹ was 0.17 coupled with genetic advance was 0.14 . Our findings are in contrast to Farshadfar and Estehghari (2014) who noted moderate broad sense heritability among the wheat lines. Grains weight spike⁻¹ showed significant positive correlation with 100 grain weight while observed non-significant correlation with all other studied traits.

100-Grain weight

The CV and R^2 for 100-grain weight were 5.98% and 0.672, respectively (Table 1). Least significant difference (LSD 5%) for 100-grain weight was 0.53g. Mean values for 100-grain weight of wheat genotypes ranged from 5 to 6.40 g (Table 2). Environmental variance for 100-grain weight (0.11) was greater than genetic variance (0.10). The broad sense heritability (h^2) for 100-grain weight was 0.48 and genetic advance observed for 100-grain weight was 0.46 (Table 3). There was no significant association of 100-grain weight with all other studied traits.

Biological yield

The analysis of variance showed highly significant genetic differences ($P < 0.01$) among wheat genotypes for biological yield (Table 1). These findings are also encouraged by Afridi and khalil (2007). The coefficient of variation (CV) and determination for biological yield was 21.81% and 0.761, respectively. Least significant difference (LSD 5%) for biological yield was 1553 kg ha⁻¹. The mean values of wheat genotypes for biological yield ranged from 2222 to 7778 kg ha⁻¹ (Table 2). Environmental variance for Biological yield was greater (909739) than genetic variance (784894). The broad sense heritability (h^2) for biological yield was 0.46 with genetic advance value of 1242 (Table 3). Biological yield showed significant positive association with grain yield and negative correlation with harvest index (Table 4). Similar finding reported by Iqbal *et al.*, (2017) who noted that biological yield has positive and significant association with the grain yield.

Grain yield

Differences among genotypes for grain yield and yield related traits in wheat is the most important concern in wheat plant breeding programs (Talebi *et al.*, 2009). Mean values for grain yield of wheat genotypes ranged from 1204 to 3287 kg ha⁻¹ (Table 2). Environmental variance for Grain yield was greater (352404) than genetic variance (99941). The broad sense heritability (h^2) for grain yield was 0.22 and value of genetic advance was 306 (Table 3). However, Kahrizi *et al.* (2010) reported low heritability estimates for grain yield. There was non-significant correlation of grain yield with all other studied traits (Table 4). Our result are in contrast (Aycecek and Yildirim,

2006) who reported that grain yield plant⁻¹ showed significantly positive association with number of productive tillers plant, plant height, 1000- grain weight and spike length at genotypic and phenotypic levels.

Harvest index

Harvest index of wheat genotypes ranged from 39% to 58% among wheat genotypes. Environmental variance for harvest index was greater (21) than Genetic variance (18). The broad sense heritability (h^2) for harvest index was 0.46 coupled with low genetic advance was 6.02 (Table 3). Gupta and Verma (2000) reported low heritability for harvest index. Ferdous *et al.*, (2010) and Sharma (2007) reported high genetic advance.

In conclusion the results of the study showed that for all the traits the genotypes differed significantly except tillers m⁻². Furthermore, phenotypic correlation revealed positive correlation of grain yield with plant height, spike length, fertile tillers and biological yield, suggesting that more importance should be given to these traits for improving the yield in wheat. Genotypes G-9, G-11 and G-34 showed better performance for grain yield as compared to other's genotypes and thus recommended for cultivation under rainfed conditions of Khyber Pakhtunkhwa, Pakistan.

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Table 1: Mean squares values for wheat genotypes

Parameters	Replication	Genotypes	Error	CV (%)	R ²
DF	2	35	70	-	-
Days to 50% Heading	1.15	23.7**	2.78	1.58	0.81
Flag leaf area	120.5	16.2**	4.7	16.29	0.71
Tiller's meter ⁻²	12652.8	3753.1 ^{ns}	2937.1	31.38	0.43
Plant height	328.8	60.5**	16.7	5.45	0.70
Spike length	2.15	1.69**	0.48	6.96	0.65
Spikelet spike ⁻¹	13.3	5.9**	1.8	7.60	0.64
Grain spike ⁻¹	156.83	66.60*	40.72	12.58	0.48
Grain weight spike ⁻¹	0.39	0.21*	0.13	13.83	0.47
Biological yield	4007916	3264420**	909738	21.81	0.76
Grain yield	8952225	652327*	352504	30.24	0.62
Hundred grain weight	0.48	0.42**	0.11	5.98	0.67
Harvest index	104.43	76.09**	85.28	20.35	0.65

** = Significant at 1% probability level and ns =non-significant, respectively

Table 2: Mean, range and LSD value for all the traits

Parameters	Mean	Range	LSD(5%)
Days to 50% heading	105	100-109	2.71
Flag leaf area	13	9-21	3.51
Tiller's meter ⁻²	173	114-279	88.21
Plant height	75	61-85	6.66
Spike length	10	9-12	1.12
Spikelet spike ⁻¹	18	15-21	2.21
Grain spike ⁻¹	51	41-62	10.39
Grain weight spike ⁻¹	2.61	2.1-3.3	0.59
Biological yield	4372	2222-7778	1553
Grain yield	1964	1202-3287	967
Hundred grain weight	5	5-6	0.54
Harvest index	45	39-58	15.11

Table 3: Broad sense heritability estimates for studied traits

Traits	V _g	V _p	V _e	h ²	GA
Days to heading	6.97	9.74	2.78	0.71	4.60.
Flag leaf area	3.86	8.51	4.65	0.45	2.73
Tiller's meter ⁻²	272	3209	2937	0.08	9.89
Plant height	14.59	31.31	16.72	0.47	5.37
Spike length	0.40	0.88	0.48	0.46	193
Spikelet spike ⁻¹	1.34	3.19	1.85	0.42	1.55
Grain's spike ⁻¹	8.63	49.35	40.72	0.17	2.53
Grain weight spike ⁻¹	0.03	0.16	0.13	0.17	0.14
100-grain weight	0.10	0.21	0.10	0.48	0.46
Biological yield	784894	1694632	909739	0.46	1242
Grain yield	99941	422445	352504	0.22	306
Harvest index	18	40	21	0.46	6.02

Table 4. Correlation among various studied traits

	Tillers / m ²	Flag leaf area	Plant height	Spike length	Spikelet / spike	Grain / spike	Grain weight / spike	Biological yield	Grain yield	100 grain weight	Harvest index
Day to heading	-0.25	0.09	0.12	-0.01	0.09	-0.26	-0.14	-0.31	-0.27	0.24	0.14
Tillers / m ²		0.14	0.34*	0.20	-0.03	-0.02	-0.29	0.64**	0.64*	-0.44**	-0.13
Flag leaf area			0.16	0.55*	0.43**	0.43*	0.29	0.29	0.37*	-0.07	0.14
Plant height				0.50*	0.24	0.02	-0.01	0.55**	0.55*	-0.07	-0.09
Spike length					0.67**	0.49*	0.49**	0.31	0.40*	0.01	0.13
Spikelet per spike						0.71*	0.65**	0.20	0.23	0.13	-0.03
Grain per spike							0.72**	0.13	0.15	-0.17	-0.03
Grain weight / spike								-0.11	-0.09	0.44**	0.08
Biological yield									0.9**	-0.29	-0.34*
Grain yield										-0.24	0.02
Hundred grain weight											0.18

*' ** = Significant at 5 and 1% probability level, respectively

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