RESEARCH ARTICLE

GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS IN WHEAT

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Abstract: A field study was conducted in Punjab Agricultural University during 2016 under restricted irrigation condition to study the genetic variability, genetic advance, correlation and path analysis of yield contributing characters of 27 Iranian wheat landraces. Genotypic and phenotypic correlation studies reveals that tillers per metre row length, spikelet per spike, grains per spike , grain weight and harvest index is significantly and positive correlated with grain yield at 1% and 5% probability level. Therefore, these characters may be effective as selection indices during breeding programmes for improving grain yield. The result of path analysis signifies that tillers per metre row length, spikes per spike and grain weight have positive direct effect on grain yield whereas plant height and spikelet per spike have negative direct effect on grain yield. Furthermore, maximum heribility and genetic advance was recorded in grain weight and spikelet per spike. So, this character should be considered as suitable selection criteria for the development of high yielding varieties in wheat.

Keywords: Genetic variability, Correlation coefficient, Path analysis and Iranian wheat landraces

INTRODUCTION

Wheat is one of the most important cereal crop , it ranks first in area coverage and second in total production after maize, wheat provides more nourishment than any other food crops(FAOSTAT 2019). Abiotic stresses such as drought, salinity, excessive watering, extreme temperature and salinity affect growth and development processes in plants. Among these, drought is major abiotic stress that is the most detrimental stress that affects overall productivity in crops; therefore, improving yield under drought is one of the cardinal concern of plant breeders. Drought stress affects the growth of plant from seedling to full maturity which results in reduction of yield (Bilal *et al*. 2015).Under drought conditions, decreasing pattern was experienced in morphologically yield contributing characters like grains per spike, spikelet per spike,1000 grain weight in wheat (kilic and Yagbasanlar 2010).The amount ,speed and duration of grain formation significantly reduced under water stress due to limited supply of assimilates to the grain which reduce 1000 grain weight and grain yield (Gooding *et al*. 2003).Grain yield has positive correlation with grains per spike, spikelet per spike and 1000 grain weight while, grain weight and spikes per spike is positively correlated with 1000 grain weight and harvest index. As yield in wheat is highly complex trait and is directly or indirectly affects by several contributing factors such as by number of tillers, grains per spike, spikelet per spike and thousand grain weight. So the breeders are naturally interested in investigating the extent and type of association of such traits (Zafarnaderi *et al* 2013). Genotypic and phenotypic association is an important statistical method by which association of yield contributing characters can be studied. If two traits are positively correlated, then one trait can be improved indirectly by improving the other trait. So knowledge of correlation is vital for plant breeders for increasing the productivity of crop. Correlation studies along with path analysis provide a better insight of the association of different characters with grain yield. Path coefficient analysis separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficient (Dixit and Dubey, 1984).Path analysis was used by several researchers with the objective to determine the effects of important yield components (Mehetre *et al*. 1997, Naazar *et al*. 2003 and Ahmed *et al*. 2003). Broad-sense heritability is defined as the ratio of genotypic variance to the phenotypic one. The knowledge of heritability is quite helpful for the plant breeders in estimating the behavior of succeeding generation and making desirable selection. Genetic advance is another genetic parameter which indicates the magnitude of the expected genetic gain from one cycle of selection (Hamdi *et al*. 1992). Phenotypic and genotypic coefficients of variations, heritability and genetic advance have been used to study the magnitude of variance in wheat breeding material. The aim of the present study is to determine the probable phenotypic, genotypic correlation, direct and indirect effects of yield components, broad sense heritability and expected genetic advance in Iranian wheat landraces.

MATERIALS AND METHODS

An experiment was carried out in Punjab Agricultural University during 2016 for evaluating the effect of water stress on morpho-physiological traits of Iranian wheat landraces. 27 lines were selected on the basis of vigor index from preliminary screening experiment. Selected Iranian landraces on

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the basis of minimum reduction of vigor index under stress conditions as compared to control experiment. These lines showed minimum reduction as compared to control in all seedling parameters at 14% Polyethylene glycol (6000) treatment (Kaur *et al*. 2018). 27 Iranian landraces were grown in field conditions under water stress conditions. The experiment was carried out in RBD design with three treatments with three replications. Sowing was done in last week of November 2016. Pant height was measured in centimeters from base of the plant to the tip of the spike and tillers per metre row length was calculated by using scale of 1 meter .Number of spikelet was counted from 3 randomly selected spikes for each line and for grains per spike, 5 spikes were randomly selected and thrashed at maturity was recorded as grain per spike. Number of grains was counted and grains were weighted to calculate thousand grain weight. Harvest index was calculated according to formula

$$Harvest\ index = \frac{Grain yield}{Biological\ yield}$$

Genotypic coefficient of variation (GCV%), Phenotypic coefficient of variation (PCV%), broad sense heritability (h^2(bs)%) and Genetic advance in percent mean (GAPM) were estimated by the formula suggested by Singh and Chaudhary (1985.While, the genotypic correlation, phenotypic correlation and path analysis was carried out as suggested by Dewey and Lu (1959) by using software R package Version 0.1.0. (Popat *et al*. 2020).

RESULTS AND DISCUSSION

Table 1. Genetic parameter for yield contributing characters in Iranian wheat landraces

Trait	Mean	Min	Max	PCV	GCV	h^2bs	GA
PH	81.8	68.5	90.5	6.89	6.32	0.84	11.9
TPMRL	68	43.5	90	17.1	10.7	0.39	13.8
SPS	24.9	16	34.5	13.7	13.4	0.95	27
GPS	18.4	15.3	23	5.73	3.26	0.32	3.82
GW	25.4	18	39.6	17.4	16.9	0.93	33.8
HI	0.2	0.09	0.33	27.6	15.2	0.3	17.2
GY	161	50	330	32.2	24.8	0.95	39.5

PCV(%)- Phenotypic coefficient of variation GCV(%)- Genotypic coefficient of variation, h^2bs (%) broad sense heritability and GA(%)- Genetic advance

The results of genetic parameters that was mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense (h^2) and expected genetic advance as percent of mean for all the characters depicted in (Table 1).The magnitude of genetic variability of plant height ranged between 68.5 cm to 90.5cm with a mean of 81.8 cm. The magnitude of genetic variability of tillers per meter row length and spikelet per spike was ranged from 43.5 to 90 and 16 to 34.5 respectively. Similarly for other characters magnitude of genetic variability was recorded. The genotypic coefficient of variation ranged between 6.32 percent and 24.8 and phenotypic coefficient of variation from 5.73 percent to 32.2. Grain yield had the highest PCV and GCV value similar results were found by Ali *et al*. (2008).The lowest PCV and GCV value recorded for grains per spike were (5.73) and plant height (6.32) respectively. The PCV values were higher than GCV values for all the characters which clearly indicate the greater effect of environment in expression of traits. Similar results were presented by Singh *et al*. (2018) and Varsa *et al*. (2019). Heritability is a useful quantitative parameter, which considers the role of heredity and environment determining the expression of a trait .The highest heritability was recorded for grain yield (0.95) and spikelet per spike (0.95) which was followed by grain weight (0.93) and plant height (0.84). High heritability estimates for grain yield was also recorded by Kumar *et al*. (2013), Kaul and Singh (2011), Khan *et al*. (2010) and Salem *et al*. (2006). Expected genetic advance indicates the expected genetic progress for particular trait under selection cycle and measures the extent of its stability under selection pressure. The highest value was recorded for grain yield, grain weight and spikelet per spike, and lowest for plant height followed by tillers per metre row length and grains per spike. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone in selecting best individuals (Johnson *et al*. 1955).

High heritability along with moderate genetic advance was noticed for thousand grain weight and spikelet per spike suggesting predominance of additive and non-additive gene action in the expression of this trait. Therefore, these traits can be improved by mass selection. High heritability for plant height coupled with low expected genetic advance indicates non-additive gene effects. Therefore, seems a limited scope for improvement in

this trait. Akanda *et al*. (1997) reported that high genotypic coefficient of variation along with high heritability and genetic advance provide better information than other parameters along with high heritability and genotypic coefficient of variation (Table 2). These traits are the most important traits to be taken into consideration for effective selection in wheat.

Genotypic and phenotypic correlation

Table 1. Genotypic correlation coefficient among seven traits of Iranian wheat landraces

Trait	PH	TPMRL	SPS	GPS	GW	HI	GY
PH	**0.9****	-0.535**	-0.036ns	-1.049**	0.154**	-0.296ns	-0.416*
TPMRL	-0.535**	**1.112****	0.066ns	0.605**	-0.428**	0.354*	0.245*
SPS	-0.036ns	0.066ns	**0.936****	0.502**	-0.193ns	0.02ns	0.20*
GPS	-1.049**	0.605**	-0.502**	**-0.408***	-0.264ns	0.773**	0.897**
GW	0.1541ns	-0.428*	-0.02ns	-0.264ns	**0.915****	-0.14ns	0.169**
HI	-0.296ns	0.354*	0.05ns	0.773**	-0.142ns	**0.974****	0.654**

PH- Plant height, TPMRL- Tillers per meter row length. SPS- Spikelet per spike, GPS- Grains per spike, GW- Grain weight and HI- Harvest index

**** Significant and highly significant at 1% and 5% level and r_g= Genotypic correlation**

Table 3. Phenotypic correlation coefficient among seven traits of Iranian wheat landraces

Trait	PH	TPMRL	SPS	GPS	GW	HI	GY
PH	**1.066****	-0.349**	0.220ns	-0.131ns	0.280**	-0.18ns	-0.36**ns
TPMRL	-0.349**	**0.957****	0.101**	0.100ns	-0.244*	-0.13ns	0.354*
SPS	0.220ns	0.101ns	**1.107****	0.154*	-0.023ns	0.052ns	0.160*
GPS	-0.131ns	0.100ns	0.154ns	**0.143****	-0.210ns	0.204ns	0.371**
GW	0.280*	-0.244*	-0.023ns	0.210ns	**1.042****	-0.07ns	0.121**
HI	-0.186ns	-0113ns	0.058ns	0.204ns	-0.070ns	**1.007****	0.184**
GY	-0.386**	0.004ns	-0.160ns	0.371**	0 121ns	0.184ns	0.970**

PH- Plant height, TPMRL- Tillers per meter row length. SPS- Spikelet per spike, GPS- Grains per spike, GW- Grain weight and HI- Harvest index

**** Significant and highly significant at 1% and 5% level and r_p= Phenotypic correlation**

Plant height was negatively but significantly associated with tillers per plant, grains per spike and grain yield at genotypic level whereas, at phenotypic level it was significantly correlated with grain weight (0.289*) and non-significantly with spikelet per spike (0.22). The correlation between plant height and grain yield plant was negative and significant at both phenotypic and genotypic levels (r_p = -0.4163*, r_g = -0.3862**). It indicates that selection of short stature genotypes could be effective for higher grain yield. Similar results have been found by Iqbal *et al*. (2007) and Khokhar *et al*. (2010). Number of tillers per plant is significantly and positively correlated with grain yield at both phenotypic and genotypic level (r_g 0.245* r_p=0.354*). Similar result were revealed by Ali *et al* 2008, Dogan (2009) , Gashaw *et al*. (2007) Usman *et al*. 2006 in wheat whereas, significant and negative correlation was found at both phenotypic and genotypic level with grain weight.

Tillers per plant were significantly associated with spikelet per spike at genotypic and phenotypic level. Number of spikelet per spike was significantly and positively correlated with grain yield at both phenotypic and genotypic level (r_p= 0.202 r_g=0.160) .A highly and positive correlation was observed between numbers of spikelets per spike and numbers of grains per spike that was accordance with the findings of Mohammad *et al*. (2002) and Kashif and Khaliq (2004). While, number of spikelet per spike was non-significantly correlated with number of tillers and harvest index at both phenotypic and genotypic level. Grains per spike is significantly and positively correlated with grain yield (0.773*) and harvest index (0.897*) at both genotypic and at phenotypic level it was positively and significantly correlated with grain yield (0.371*) at phenotypic level which means that grains per spike is an important trait for enhancing the crop productivity. Similar results were revealed by Khaliq *et al*. (2004) and Akram *et al*. (2008).

Thousand grain weight and harvest index is significantly and positively correlated with grain yield at both phenotypic and genotypic level (r_p=0.121** r_g= 0.169** and r_p=0.1843** and r_g=0.654**) respectively. Similar results were revealed by Rehman *et al*. 2015, Aycecik & Yildirim (2006) and Inamullah *et al*. (2006) who also noticed positive association of 1000 grain weight with grain yield. A significant and positive correlation was found between grains per spike and grain yield at

both genotypic and phenotypic level which indicates that number of thousand grain weight and harvest index should be given prime importance regarding their contribution to yield.

Path Coefficient Analysis

Table 4. Genotypic path coefficient analysis (Direct and indirect effects) of six characters on grain yield in Iranian wheat landraces

Trait	PH	TPMRL	SPS	GPS	GW	HI
PH	**-0.3298**	0.0074	0.0063	0.0438	0.0448	-0.1889
TPMRL	-0.0115	**0.1962**	-0.0115	-0.0253	-0.1243	0.2258
SPS	0.0131	-0.0009	**-0.1632**	0.0209	-0.0560	-0.0166
GPS	0.3845	-0.0084	0.0875	**0.0170**	-0.0767	0.4932
GW	-0.0566	0.0059	0.0336	0.0110	**0.2657**	-0.0907
HI	0.1086	-0.0049	0.0045	-0.0323	-0.0412	**0.6194**

Bold figures denotes direct effects while, regular figures denotes indirect effects

PH- Plant height, TPMRL- Tillers per meter row length. SPS- Spikelet per spike, GPS- Grains per spike, GW- Grain weight and HI- Harvest index

Residual effect =0.38

Plant Height Versus Grain Yield

Plant height directly affected the grain yield in negative direction. The negative direct effect of plant height was highly great (-0.329), and its correlation with grain yield plant was negative. (Table 4). The result of present findings are similar with the findings of Khan *et al*. (2010), Ashraf *et al* (2012), Ali *et al*. (2008) and Rajput (2018). It is owing to maximum proportion of dry matter accumulation towards the height of the plant. Indirect effects of plant height via, number of tillers per plant, spikelet per spike, grains per spike and 1000-grain weight was positive [39] whereas, it was negative through harvest index.

Tillers Per Metre Row Length Versus Grain Yield

Tillers had positive direct effect on the grain yield (0.1962) which means that tillers directly contribute to increase the yield of crop similar result were reported by Kamboj *et al*. (2010) and Khan et al (2005) .The indirect negative effect via grains per spike, spikelet per spike and grain weight was recorded.

Number of spikelet per spike versus grain yield

According to path analysis, number of spikelet per spike had negative direct effect (-0.16) on grain yield and had maximum positive indirect effect through number of grains per spike (0.02) (Table 4) .Similar result were revealed by Subhani and Chowdhry (2000), Tammam *et al*. (2000), Shahid *et al*. (2002) and Lad *et al*. (2003).

Number of grains per spike versus grain yield

Number of grains per spike had direct effect on grain yield and it is concluded that grain yield could be increased significantly by increasing the number of grains per spike so direct selection for this will be reliable. Shahryari (2011) and Vamshikrishna *et al*. (2013) also found that in wheat genotypes number of grains per spike had positive direct and its positive association with grain yield in wheat genotypes and these findings support the current findings. The indirect effect via plant height (0.38), spikelets per spike (0.08) and harvest index (0.49) was also positive (Table 4)

Thousand grain weight versus grain yield

Thousand grain weight had direct positive effect on yield with value of 0.2657, suggesting that its role in breeding programmers for developing the genotypes having maximum grain yield (Sogi *et al*. 2006 and Khan *et al*. 2005). The indirect effect via number of tillers, spikelets per spike and grains per spike was positive whereas, it was negative via plant height (-0.05) (Table 4)

Harvest index versus grain yield

Harvest index had direct effect on grain yield having value of 0.619. The genotypic correlation between tillers per plant (0.65) and the grain yield is almost equal to its direct effect (0.61), thus it shows true relationship and direct selection for higher harvest index would be enough to obtain high grain yield (Sherwan *et al*. 2016). The indirect effect via spikelet per spike and plant height was positive while, negative indirect effect via number of tillers, grains per spike and thousand grain weight was found negative.

CONCLUSION

The result of correlation revealed that plant height negatively affects the grain yield of crop whereas, tillers per metre row length, grains per spikelet, grain weight and harvest index is positively and significant correlated with grain yield which means that improvement in any of this trait will increase the yield of crop. Maximum positive direct effect in grain yield by harvest index , followed by grain weight tillers per metre row length and grains per spike This means slight increase in anyone of this can increase the grain yield whereas negative effect on grain yield by spikelet per spike and plant height that would be the appropriate selection criteria for raising grain yield. The highest heribility coupled with genetic advance was recorded in spikelet per

spike, grain weight and tillers per metre row length. Hence, knowledge regarding genetic parameters such as genetic correlation coefficient, coefficient of variation, heritability and genetic advance could be helpful for the breeders to develop better cultivars within a short duration.

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