J. Wheat Res. 5 (2) : 48-51

Received: 30 July 2013/ Accepted: 18 September 2013

Genetic variability, correlation and path analysis in wheat

Vamshikrishna Nukasani, Nilkanth Ramchandra Potdukhe*, Swati Bharad, Shradha Deshmukh and Sachin Murlidhar Shinde

Punjabrao Deshmukh Krishi Vidhyapeeth
Akola-444 104, India

Abstract

Hundred fourteen pre-breeding lines of wheat were evaluated for variability. High values of GCV and PCV were recorded for tillers meter^{-1} and grain yield meter^{-1}, whereas moderate values for rest of the traits. High heritability coupled with high genetic advance were recorded for traits plant height, tillers m^{-1}, grain yield m^{-1}, grain wt spike^{-1} and spike length indicating that these characters are governed by additive gene effects and directional selection for these traits would be more effective. Correlation and path analysis studies revealed that, three characters, tiller number m^{-1} >grain weight spike^{-1} >number of grains spike^{-1} in that order are the most important characters as these exhibited positive and strong association and maximum positive direct effects on grain yield. Therefore while imparting the selection in wheat characters tiller number m^{-1}, grain weight spike^{-1} and number of grains spike^{-1} must be given preference.

Keywords: Pre-breeding lines, heritability, genetic advance, correlation and path coefficient

Introduction

Wheat is the world's most important crop that excels all other cereal crops both in area and production, thereby providing about 20.0 per cent of total food calories for the people of the world. The extent of genetic variability has been considered as an important factor which is an essential pre-requisite for a successful hybridization aimed at producing high yielding progenies. The selection of parents becomes more difficult if the improvement is made for a polygenetically controlled complex character like grain yield. Since, efficient selection of genetically superior individuals requires adequate phenotypic variance in the base population and sufficient high heritability. Correlation studies along with path analysis provide a better understanding of the association of different characters with grain yield. Correlation is useful in disclosing the magnitude and direction of the relationship between various yield contributing traits and yield. While path coefficient (or) standardized partial regression coefficient that measures the direct effect of a predictor variable upon its response variable and the second component being the indirect effect(s) of a predictor variable (Dewey and Lu, 1959).

Therefore the efforts were made to study the extent of variability, heritability and possible amount of genetic gain expected to occur during the selection for yield improvement. Similarly, an attempt was made to analyze grain yield and its attributing traits of wheat by correlation and path coefficient analysis.

Materials and methods

Experimental material consisting of 114 pre-breeding lines, which were selected from the germplasm pool of wheat were grown in randomized block design (RBD) with three replications during *Rabi* 2010-11 at Wheat Research Unit, Dr. P.D.K.V Akola (M.S.). Pre-breeding lines were grown in two rows of 2 meter row length with spacing of 30 and 10 centimeter between rows and plants respectively. Recommended package of practices and plant protection measures were followed for healthy crop growth during the season. Five randomly selected plants per line per replication were used for recording the observations plant height, tillers m^{-1}, spike length, spikelets spike^{-1}, number of grains spike^{-1}, grain weight spike^{-1}, 1000 grain wt. and the observation on grain yield m^{-1} was recorded on plot basis. The genetic parameters of variability, estimation of heritability and genetic advance were computed according to the method suggested by Johnson *et al.,* (1955). The character association was estimated from variance and covariance components as given (Fisher, 1954 and Al-Jibouri *et al.,* 1958). While the direct and indirect effects of component traits up on grain yield were measured by path analysis as described by Dewey & Lu (1959).

Results and discussion

Analysis of variance revealed that the mean sum of squares of various characters Viz. plant height, tillers m^{-1}, spike length, spikelets spike^{-1}, number of grains spike^{-1}, grain wt. spike^{-1}, 1000 grain wt. and grain yield m^{-1} are significant thereby indicated the presence of sufficient amount of variability among the pre-breeding lines selected for the study.

Data presented in Table 2 revealed that, almost equal magnitude of GCV and PCV revealed for the characters plant height, tiller number, 1000 grain weight and spike length indicating that these characters are less influenced

*Corresponding author's email: *nrpwheat2009@rediffmail.com*

Table 1. Analysis of variance for eight metric traits in wheat

Source	df	Mean sum of squares							
		Plant height	Tillers/ meter	Spike length	Spikelets/ spike	Grains/ spike	Grain wt	1000 grain wt	Grain yield
Replications	2	9.782	0.429	0.524	1.506	22.370	0.027	2.089	787.601
Genotypes	113	431.38**	2494.31**	7.81**	13.68**	176.36**	0.470**	113.62**	10392.58**
Error	226	12.163	19.934	0.242	0.781	18.079	0.054	1.317	819.898

by the environment. High values of GCV and PCV were recorded for tillers meter^{-1} and grain yield meter^{-1}, moderate values were recorded for 1000 grain weight, spike length, grains spike^{-1}, plant height and spikelets spike^{-1} while grain wt spike^{-1} character exhibited high value of PCV alone, and indicating large amount of variation for this character among the lines was due to the environment only. Earlier wheat researchers (Monpara, 2011, Singh *et al*., 2012 and Tsegaye *et al*., 2012) also reported similar results.

The range observed for heritability in broad sense was from 71 to 97 per cent and maximum heritability was recorded for the character tillers meter^{-1} followed by 1000 grain wt., plant height, spike length, spikelets spike^{-1}, grain yield m^{-1}, grains spike^{-1} and grain weight spike^{-1}. Present findings are in confirmation with Monpara, 2011 and Singh *et al*., 2012.

The results indicated that the expected genetic advance over mean was in the range (22.67% to 47.45%) and highest expected genetic advance to the extent of 47.45 per cent was observed for the character tillers meter^{-1} and it was followed by grain yield m^{-1}, spike length, grain wt spike^{-1}, 1000 grain weight, grains spike^{-1}, plant height and spikelets spike^{-1}. Similar results were reported by Sharma *et al.,* 2006 for tillers plant^{-1}, grain yield and no. of grains ear^{-1} in wheat, while Singh *et al*., 2012 observed low genetic advance for spike length, tillers m^{-1} and 1000 grain weight.

Correlation analysis (Table 3) revealed that the association between yield and yield contributing characters was found positive and significant only for three characters namely tillers m^{-1} (0.6401); grain weight spike^{-1} (0.4928) and grains spike^{-1} (0.2211). Selection for these characters can directly be followed for immediate yield improvement of wheat crop. The characters spike length, 1000 grain weight and plant height also exhibited positive association with yield however the magnitude of correlation coefficient was less indicating that during selection these characters cannot be neglected.

While the character spikelets spike^{-1} exhibited negative and non significant association with grain yield, indicating that the direct selection for this character may not be helpful for improving the yield and for that indirect selection will have to be followed via grains spike^{-1} and grain weight spike^{-1}. Present findings are in confirmation with (Ahmed *et al.,* 2010 and Singh *et al.,* 2012)showing strong association of yield with component traits viz. tillers m^{-1}, grain weight spike^{-1} and grains spike^{-1} suggested that grain yield potential can be effectively improved by obtaining maximum expression of spike length, spikes plant^{-1}, grains spike^{-1} and grain weight spike^{-1} etc.

Among the associations of yield contributing characters themselves tillers m^{-1} has exhibited negatively significant association with character grains spike^{-1} (-0.3878), spikelets spike^{-1} (-0.3696), grain weight spike^{-1} (-0.3292) and 1000

Table 2. Range, mean, genotypic and phenotypic coefficients of variation, heritability and genetic advance for different characters in wheat

Character	Range			GCV	PCV	Heribility	GA	EGA
	Min	Max	Mean+ SE(m)					
Plant height	72.11	127.25	91.09± 2.00	12.97	13.53	92	23.36	25.64
Tillers/ meter	63.0	204.0	123.20±2.57	23.31	23.59	97	58.46	47.45
Spike length	4.96	12.83	9.02±0.28	17.61	18.43	91	3.13	34.64
Spikelets/ spike	12.86	25.43	17.33±0.51	11.96	13.00	84	3.93	22.67
Grains/ spike	22.86	62.44	42.42±2.44	17.12	19.84	74	12.91	30.44
Grain weight/ spike	1.05	2.83	1.88±0.13	19.72	23.28	71	0.65	34.42
1000 grain weightt	26.94	69.17	39.54±0.66	15.47	15.74	96	12.39	31.33
Grain yield/ meter	109.67	406.62	229.11±16.46	24.66	27.64	79	103.79	45.30

Table 3. Genotypic (upper diagonal) and phenotypic (below diagonal) correlation coefficients among eight traits of wheat

Character	Plant height	Tillers/ meter	Spike length	Spikelets/ spike	Grains / spike	Grain weight	1000 grain weight	Grain yield
Plant height	-	-0.1200	0.2329*	-0.0212	-0.0059	0.2146*	0.3547**	0.0574
Tillers/ meter	-0.1142	-	0.1307	-0.3696**	-0.3878**	-0.3292**	-0.1885*	0.6401**
Spike length	0.2272*	0.1225	-	0.1398	0.0301	-0.0413	-0.0808	0.0914
Spikelet/ spike	-0.0237	-0.3289**	0.1338	-	0.6423**	0.2557**	-0.2181*	-0.1326
Grains/ spike	0.0008	-0.3340**	0.0306	0.5048**	-	0.6898**	-0.2120	0.2211*
Grain weight	0.1574	-0.2808 **	-0.0457	0.2029*	0.4870**	-	0.3692**	0.4928**
1000 grain weight	0.3380**	-0.1840	-0.0740	-0.2008*	-0.1772	0.3030**	-	0.0796
Grain Yield/meter	0.0330	0.5794 **	0.0671	-0.1004	0.1522	0.5954**	0.0643	-

*, ** significant at 5 and 1 per cent respectively.

grain weight (-0.1885) indicating that the improvement in number of tillers, if selection imparted may hamper the *per se* performance of these character. Association of tiller number with spike length (0.1307) is non-significant but in positive direction, hence while imparting the selection for tiller numbers, spike length should also be equally considered. Character spikelets spike^{-1} has strong association with grains spike^{-1} (0.6423) followed by grain weight spike^{-1} (0.2557) in positive direction however it has also strong association with tillers m^{-1} (-0.3696) and 1000 grain weight (-0.2181) but in negative direction indicating that the improvement in tillers m^{-1} and 1000 grain weight, if selection imparted may hamper the per se performance of character spikelets spike^{-1}.

Plant height exhibited significant positive association with 1000 grain weight (0.3547), spike length (0.2329) and grain weight spike^{-1} (0.2146) while the character grains spike^{-1} exhibited very strong positive association with grain weight spike^{-1} (0.6898) followed by spikelets spike^{-1} (0.6423). Similarly grain weight spike^{-1} exhibited strong positive association with grains spike^{-1} (0.6898), 1000 grain weight (0.3692) and spikelets spike^{-1} (0.2557), while moderate association with plant height (0.2146). As regards the spike length it has positive and significant association with plant height and positive association with traits like spikelets spike^{-1}, tillers m^{-1} and grains spike^{-1} however the strength of association is less. 1000 grain weight is also an important trait and exhibited positive and significant association with grain weight spike^{-1} (0.3692) and plant height (0.3547), while the association with rest of the traits is negative and strength is weak.

Sharma *et al.,* 2006; Ahmed *et al.,* 2007; Monpara and Kalariya, 2009; Singh *et al.,* 2010, Sakhare and Ghawat, 2011 and Singh *et al*., 2012 reported stronger or weaker association of yield with yield component traits in wheat and suggested that wheat crop grain yield potential can be effectively improved by obtaining the maximum expression of yield contributing characters showing the stronger association in desirable direction.

Data presented (Table 4) revealed that characters tillers m^{-1} exhibited highest positive direct effect on grain yield (0.8922) and strong association with grain yield (0.6401). Singh *et al*., 2009 and Kamboj *et al.,* 2010 also reported similar results in wheat. Grain weight spike^{-1} also exhibited maximum positive direct effect on yield (0.7740) and exhibited strong association with grain yield (0.4928), similar results were reported by Sharma *et al.* (2006) and Ahmed *et al.* (2007). Singh *et al.* (2009) reported that the association of grain yield with tiller number, grains spike^{-1}, 1000 grain weight and plant height was found to be positive nad significant under different environments.

Important trait spike length exhibited positive direct effect on grain yield however magnitude is less and it has maximum positive indirect effect *via* plant height, spikelets spike^{-1} and tillers m^{-1} on grain yield. Sharma *et al.* (2006) reported the similar results in wheat. Direct effect of spikelets spike^{-1} on grain yield are negative, however its indirect contribution is *via* grain weight spike^{-1}, grains spike^{-1}, 1000 grain weight as well as spike length. Present findings are in confirmation with Cifci *et al*., 2012. Direct effect of grains spike^{-1} on grain yield was in positive direction and maximum indirect positive effects are *via* grain weight spike^{-1}.

Plant height had positive direct effect on grain yield, while spikelets spike^{-1} and 1000 grain weight had negative direct effect on grain yield although the magnitudes are very small. Similar findings were reported (Kashif and Khaliq, 2004) in wheat for plant height, spikelets spike^{-1} and 1000 grain weight. The residual factor value was found to be 0.1788 indicated that there are some other factors influencing the grain yield, which were not being included in study.

Table 4. Direct (diagonal) and indirect effects of eight traits on grain yield

Character	Plant height	Tillers/ meter	Spike length	Spikelet/ spike	Grains/ spike	Grain weight	1000 grain weight	Grain yield
Plant height	0.0105	-0.1071	0.0013	0.0009	-0.0003	0.1661	-0.0141	0.0574
Tiller/ meter	-0.0013	0.8922	0.0007	0.0162	-0.0205	-0.2548	0.0075	0.6401
Spike length	0.0024	0.1166	0.0057	-0.0061	0.0016	-0.0319	0.0032	0.0914
Spikelet/ spike	-0.0002	-0.3297	0.0008	-0.0439	0.0339	0.1979	0.0087	-0.1326
Grains/ spike	-0.0001	-0.346	0.0002	-0.0282	0.0528	0.5339	0.0084	0.2211
Grain weight	0.0022	-0.2938	-0.0002	-0.0112	0.0364	0.774	-0.0146	0.4928
1000 grain weight	0.0037	-0.1682	-0.0005	0.0096	-0.0112	0.2858	-0.0397	0.0796

R square = 0.9680, Residual effect = 0.1788, ** $p \leq 0.01$

In conclusion the high heritability values coupled with high genetic advance were recorded for traits plant height, tillers m^{-1}, grain yield m^{-1}, grain wt. $spike^{-1}$ and spike length indicating that these characters are governed by additive gene effects and directional selection for these traits would be more effective for desired genetic improvement. Correlation between yield and three characters, viz., tillers m^{-1} (0.6401); grain weight $spike^{-1}$ (0.4928) and grains $spike^{-1}$ (0.2211) was found positive and significant and therefore selection for these characters can directly be followed for yield improvement in timely sown wheat. While path coefficient analysis revealed that same traits exhibited highest positive direct effect on grain yield and each must be given preference in selection along with optimum plant height and spike length while selecting the superior types.

References

1. Ahmed B, Iftikhar RH Khalil, Muhammad Iqbal and Hidayat-Ur-Rahman (2010). Genotypic and phenotypic correlation among yield components in bread wheat under normal and late plantings. *Sarhad Journal of Agriculture* **26**(2):259-265.
2. Ahmed S, Singh SR and Mir SA (2007). Variability and path analysis studies in wheat under temperate conditions with reference to Kashmir. *Annals of Agricultural Research New Series* **28** (3&4):253-257.
3. Al-Jibouri HA, Miller PA, and Robinson HP (1958). Genotypic and phenotypic co-variances in an upland cotton cross of inter-specific origin. *Agronomy Journal* **50**:633-636
4. Cifci EA (2012). Estimation of heterosis, correlation and path analysis for grain yield per spike and some agronomic traits of durum wheat (*Triticum durum* Desf.) *Journal of Animal and Plant Sciences* **22**(3):747-752
5. Dewey DR and Lu KH (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal* **51**(9):515-518.
6. Fisher RA (1954). Statistical methods for research workers, Oliver and Boyd. Ltd. London
7. Kamboj RK (2010). Genetic variability, heritability and genetic advance in bread wheat under salinity stress conditions. *Madras Agricultural Journal* **97**(1-3):98-99.
8. Kashif M and Khaliq K (2004). Heritability, correlation and path coefficient analysis for some metric traits in wheat. *International Journal of Agriculture and Biology* **6**(1):138-142.
9. Monpara BA (2011). Grain filling period as a measure of yield improvement in bread wheat. *Crop Improvement* **38**(1):1-5
10. Monpara BA and Kalariya RP (2009). Changes in certain yield traits as influenced by differences in maturity time in bread wheat (*T. aestivum* L.) *Plant Achieves* **9**(1):335-339
11. Sakhare SB and Ghawat NP (2011). Correlation and path analysis in durum wheat. *PKV. Research Journal* **35**(1):23-25
12. Sharma V, Pawar IS and Munjal R (2006). Variability parameters, correlation and path coefficients for yield, its components and quality traits in bread wheat. *National Journal of Plant Improvement* **8**(2):153-155.
13. Singh AK, Singh SB, Singh AP and Sharma AK (2012). Genetic variability, character association and path analysis for seed yield and its component characters in wheat (*Triticum aestivum* L.) under rainfed environment. *Indian Journal of Agricultural Research* **46**(1):48-53
14. Singh BN, Vishwakarma SR and Singh VK (2010). Character association and path analysis in elite lines of wheat (*T. aestivum* L.) *Plant Achieves* **10**(2): 845-847.
15. Singh N, Singh Tejbir and Kumar Naresh (2009). Genetic variability and correlation analysis over different environments in bread wheat (*T. aestivum* L.). *Plant Achieves* **9**(2):685-688
16. Tsegaya D, Dessalegn T, Dessalegn Y and Share G (2012). Genetic variability, correlation and path analysis in durum wheat germplasm (*Triticum durum* Desf.). *Agricultural Research and Review* **1**(4):107-112