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Genetic analysis for economic traits in elite indigenous and exotic lines of bread wheat (*Triticum aestivum* L.) under timely sown high fertility conditions

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Abstract

Genetic variability and character associations were estimated based on 111 elite bread wheat (*Triticum aestivum* L.) genotypes including advanced stage material from different regions and production conditions of India and Australia, to mark the diversity for ten important agronomic traits, *viz*- plant stand, days to heading, plant height, days to maturity, tillers per plot, spike length, grains per spike, spike weight, grain yield and 1000-grain weight (TKW) during the year 2009-2010. Results revealed that enough variability was present for all these traits. High heritability with moderate to low genetic advance was estimated for three metric traits namely; days to heading, spike length and spike weight thereby showing that this could be due to non-additive gene action or presence of G × E interaction. Therefore, simple selection and developing transgressive segregants through hybridization is suggested. Presence of significant and positive correlations between plant height, TKW, grains per spike and spike weight with grain yield, suggested that further yield improvement in bread wheat might be possible by emphasizing these traits through simple selection.

Key words: Bread wheat, correlation coefficient, heritability, genetic advance

Introduction

Wheat (*Triticum aestivum* L.) is the second most important cereal crop after rice in the context to its antiquity and use as a major crop for food and nutritional security in India and also at global level. The multifold increase of wheat production in India has mainly been due to development and cultivation of semi dwarf varieties that respond well to higher inputs. Global wheat demand by the year 2020 varies between 840 and 1,050 million tons. In order to meet India's food demand for burgeoning population of more than a billion people, wheat production growth has to be increased to more than two percent per annum. But, the resources available for wheat production are likely to be significantly lower. There is also very little scope for area expansion, and therefore productivity enhancement is the only option to meet anticipated food demand particularly for the wheat.

The success of any breeding programme depends upon the magnitude 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 as reported by Ul *et al.* (2008). The heritability offers an index of transmissibility to measure the genetic relationship of a trait(s) in the population. Earlier studies conducted by various researchers across countries, have shown that high heritability alone is not enough for selection in advance generations. It must simultaneously be accompanied with substantial amount of genetic advance as reported by Memon *et al.* (2007) and Mangi *et al.* (2008). However, if a trait is controlled by non additive gene action it gives high heritability, but low genetic advance, while in the case the character where is ruled by additive gene action, heritability and genetic advance both would be high as reported by Ahmed *et al.* (2007). Selection for grain yield improvement can only be effective if sufficient genetic variability is present in the genetic material (Ali *et al.,* 2008). Quantitative traits associated with high heritability and high genetic advance have great importance in selection of genotypes in early generations (Memon *et al.,* 2007).

Grain yield in wheat, as in any other crop plants, is a complex multi-component characteristic. Therefore, an attempt was made to estimate the extent of genetic variability, heritability and correlation coefficients for plant stand, days to heading, plant height, days to maturity, tillers/plot, spike length, grains/spike, spike weight, grain yield/plot, thousand kernel weight (TKW) in bread wheat germplasm based on a set of 111 exotic and indigenous elite lines. Present paper deals with the results obtained from present study along with the possible suggestive breeding methodology enhancing productivity as well as the wheat production in India.

Material and methods

A set of 111 elite lines (diverse but widely adapted) of bread wheat (*Triticum aestivum* L.) was selected from various sources including advanced stage material from India and Australia and ensuring that material collection

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also include lines from different regions and production conditions. The each genotype of experimental material was planted in a four-row plot of 2.5 m length spaced at 23 cm between rows and 10 cm between plants within the row during *Rabi* crop season 2009-2010. The experiment was laid out across the three blocks following augmented design wherein the eight checks were repeated three times to generate precise information for economic traits. Recommended agronomic practices were followed to raise a good crop. The adjusted means of genotypes have been utilized for estimating genetic variability and other parameters following statistical procedure (Johnson *et al.,* 1955).

The observations on plant stand (number of plants per plot), days to heading, plant height, days to maturity, tillers per plot (tillers/plot), spike length, grains per spike (grains /spike), spike weight, grain yield per plot (grain yield) and 1000-grain weight (TKW) were recorded at appropriate crop stages. Analysis of variance (ANOVA) was performed by utilizing adjusted values and also to calculate coefficient of variances, heritability (h^2b) and correlation analysis by statistical software SAS version 9.2 (SAS Institute 2008).

Results and discussion

The results obtained under present study revealed that genotypes differed significantly for all the traits as evident from individual traits ANOVA (Table 1). It was also observed that genotypic variability was high and that prompted us to go for further analysis. The estimates of genetic variability parameters for all traits were worked out and are presented in Table 2.

Mean performance of 111 genotypes for ten traits revealed that number of plants per plot taken as plant stand, that varied between 18-73 with (mean 42.33), similarly the plant height varied between 73-114 cm (mean 87cm), the days to heading ranged between 74-96 (mean 84 days), maturity duration ranged between 110-126 with (mean 120 days), similarly average tillers/plot (132.72), spike length (10.66 cm), grains per spike (58 grains), spike weight (1.76g) mean plot yield (408.74g) revealed that in general the material under study had wide range of estimates for all the traits thereby indicating presence of high genetic variability.

Table 1. Analysis of variance for ten metric traits based on 111 lines of bread wheat genotype

Trait	Source of variation (Mean sum of square)				
	Total entry (t) (D.F.=110)	Total check © (D.F.= 7)	Total entry (excluding check) (e) (D.F.=102)	Checks vs entries (c vs e)(D.F.= 1)	Error (er) (D.F.=8)
Plant stand	98.60**	23.82	104.65**	4.11	54.63
Plant height	108.35**	498.14**	82.63**	2.61	21.88
Days to heading	8.05**	3.54**	8.05**	39.31**	0.88
Days to maturity	4.52**	3.35	4.48*	17.26**	3.06
Tillers/plot	758.48**	1243.82**	729.67**	299.98	228.63
1000-grain weight	26.49**	42.52**	25.58**	7.26**	1.32
Spike length	1.70**	1.63**	1.70**	2.80**	0.04
Grains/spike	81.27**	129.28**	76.94**	187.33**	8.13
Spike weight	0.18**	0.23**	0.18**	0.42**	0.00
Grain yield	12174.57**	7163.71**	12614.68**	2359.20**	331.19

*,** Significant at 5 and 1 percent level, respectively.

The genotypic and phenotypic coefficients of variation (PCV & GCV) along with heritability were calculated for 10 metric traits and are presented in Table 2. The genotypic coefficient of variation was high for most of the traits except days to heading and days to maturity. The highest estimates of heritability were recorded for spike weight followed by grain yield per plot, spike length, TKW and grains per spike. It has been suggested that high heritability may not necessarily lead to high genetic gain, unless sufficient genetic variability exists in the germplasm. High genetic advance was obtained for plant height by earlier workers (Ali *et al.* 2008). The highest heritability values coupled with high genetic advance for plant height and 1000- kernel weight were also observed in earlier studies (Ajmal *et al.,* 2009). Spike length and spikelets/spike displayed high heritability values with low genetic advance in conformity with the findings (Ul *et al.,* 2008). Some authors also reported that grains/spike exhibited moderate heritability with high expected genetic advance (Ahmed *et al.,* 2007). The highest heritability coupled with high genetic advance for plant height and 1000- grain weight as reported by Oguz *et al.* (2011) and high heritability with high genetic advance for plant height and number of tillers per plant was reported by Gulnaz *et al.* (2011).

Table 2. Estimates of variability for 10 metric traits in bread wheat genotype

Trait	Estimate of variability					
	Range	Mean	h^2	PCV	GCV	Genetic Advance
Plant stand	18-73	42.3	40%	22.56	14.33	7.95
Plant height	73-114	87.4	93%	19.87	19.13	33.16
Days to heading	74-96	84.6	86%	2.96	2.74	4.42
Days to maturity	110-126	119.7	44%	1.95	1.29	2.10
Tillers/plot	81-236	132.7	79%	24.88	22.15	54.16
1000-grain weight	16.2-40.8	28.4	96%	20.64	20.24	11.68
Spike length	7-14	10.7	97%	12.25	12.09	2.61
Grains/spike	38-78	57.9	92%	18.04	17.35	19.71
Spike weight	0.86-2.59	1.8	99%	26.12	25.98	0.92
Grain yield	105.3-590.7	408.7	97%	24.64	24.23	99.76

Where, h^2= Heritability in broad-sense, PCV= Phenotypic coefficient of variation, GCV = Genotypic coefficient of variation, Genetic advance as per cent of mean.

High heritability coupled with high genetic advance and high coefficient of variability for grain yield per plot and plant height showed scope for improvement following selections. However, in case of characters like days to heading, spike length and spike weight showing high heritability but moderate to low genetic advance, which may be due to non-additive gene action and presence of G × E interaction, simple selection may not be rewarding. In such cases hybridization followed by selecting desirable transgressive segregants will be better options.

The phenotypic correlation coefficients among 10 traits were also worked out to see the association between these traits (Table 3). If the association is positive, improvement in one character will simultaneously bring about an improvement in other. However, the negative association between two economic traits is useful for plant height, maturity duration and days to heading. The significant and positive correlation co-efficient, were found between plant height, 1000-grain weight, grains per spike and spike weight with grain yield per plot. Similarly, plant height was found to be positively and significantly correlated with 1000-grain weight (TKW), 1000-grain weight with spike length and spike weight; Grains per spike with spike weight, thereby indicating that these traits may be improved simultaneously.

The strong positive association of grain yield with one or more than one of the above studied traits has also been observed by previous workers Saktipada *et al.* (2008). Some studies indicated that 1000 kernel weight, grains per spike, tiller per meter and days to maturity have direct effect on yield (Sen *et al.,* 2007). The indirect effects of tillers per plant, grain per spike, spike weight, ear length, harvest index, plant height and days to heading were of high order positive contribution on grain yield per plant via biological yield per plant (Saktipada *et al.,* 2008). Several researchers reported that grain yield was positively correlated with 1000-grain weight (Akram *et al.,* 2008). Plant height correlated negative and significant with days to 50% flowering and spike length in case of durum wheat Akram *et al.,* 2008) and Gashaw *et al.*, 2007).

Table 3. Phenotypic correlation coefficients among 10 traits in bread wheat genotype

Trait	Plant height	Days to heading	Days to maturity	Tillers/ plot	1000-grain weight	Spike length	Grains/ spike	Spike weight	Grain yield
Plant stand	0.025	-0.175*	-0.166	0.078	-0.052	-0.146	0.054	-0.091	-0.023
Plant height	-	-0.025	0.037	-0.170	0.335**	0.053	-0.106	0.188*	0.230**
Days to heading	-	-	0.490**	0.042	-0.157	-0.172	0.198*	-0.016	-0.086
Days to maturity	-	-	-	0.023	0.232**	0.070	0.093	0.177*	0.103
Tillers/plot	-	-	-	-	-0.135	-0.196*	-0.256**	-0.303**	0.096
1000-grain weight	-	-	-	-	-	0.326**	0.110	0.621**	0.542**
Spike length	-	-	-	-	-	-	0.130	0.306**	0.192**
Grains/spike	-	-	-	-	-	-	-	0.616**	0.262**
Spike weight	-	-	-	-	-	-	-	-	0.450**

*,**, Significant at 5% and 1% level, respectively.

The correlation coefficients for grain yield per hectare, implying that improving one or more of the characters could result in high grain yield for durum wheat as reported by Bilgin *et al.* (2008) and Yagdi & Sozen (2009). Some authors also reported that grain yield per plant showed highly significant and positive correlation with biological yield per plant, grains per spike, spike weight, tillers per plant and ear length whereas, plant length has significant and positive association with grain yield (Singh *et al.*, 2010). Similar to our findings, the no. of effective tillers per plant, no. of spikelet per panicle and harvest index gave significant positive correlation with grain yield per plant both at genotypic and phenotypic level as reported by Kotal *et al.* (2010). The grain yield was positive and significantly correlated with gain weight, grains per spike, test weight, plant height, spikelet per spike, 1000-grain weight and spike length whereas, negatively with days to 50 per cent flowering as reported by Oguz *et al.* (2011).

In summary, the present study reveals that, the wide genetic variability exit, for most of the traits (grain yield per plot, grains per spike, plant height and tillers/plot) with high heritability along with high genetic advance, thereby indicating the scope for improvement in yield through simple hybridization and selection. The high and positive correlations will help in improving the grain yield through selection and the high heritability and genetic advance will be useful for population improvement through hybridization followed by selection. Significant and positive correlations between economic traits further support the breeding strategy to improve wheat yield by incorporating useful traits in future wheat genotypes.

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