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RESEARCH PAPER

Genetic variability and characters associations in the germplasm of wheat (*Triticum aestivum* L.) under rainfed conditions of Himalayas

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Abstract : Presence of genetic variability within available germplasm of wheat is essential to initiate and sustain wheat improvement using plant breeding methods. Field experiments were conducted during *Rabi* 2007-08, 2008-09 and 2009-10 with the aim of estimating variation in the germplasm and also to generate information on associations of yield components and their direct and indirect influence on the grain yield of wheat. Thirty three accessions were evaluated in Randomized Complete Block Design with three replications. Results shows that there were significant genotypic difference for seed yield per plant, 1000-seed weight, number of spikelets per spike, number of seeds per spike, spike length, plant height and days to 50 per cent flowering in all three years. Broad sense heritability estimates ranged from 0.35 for days to 50 per cent flowering to 0.78 for 1000-seed weight. Number of spikelets per spike, number of seeds per spike, spike length, and days to 50 per cent flowering had exhibited positive and significant correlation with seed yield. Number of seeds per spike, spike length, number of spikelets per spike, 1000-seed weight and number of days to 50 per cent flowering had positive and direct effects on seed yield.

Key Words : Wheat, Genetic variability, Heritability, Genetic advance, Correlation co-efficient, Path analysis

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important crop grown in Kashmir valley and other parts of India. Genetic variability, which is a heritable difference among cultivars, is required an appreciable level within a population to facilitate and sustain an effective long term wheat breeding programme. Progress from selection has been reported to be directly related to the magnitude of genetic variance in the population (Helm *et al.*, 1989; Hallauer and Miranda, 1995). Large amount of genetic variability has been observed to occur in the original accessions and races among sampled population representing different climatic and geographical regions (Illarslan *et al.*, 2002). Yield components and plant traits contribution on grain yield may be important for breeding strategies. Simple correlation analysis that relates grain yield to a single variable may not provide a complete understanding of the importance of each component in determining grain yield (Dewey and Lu, 1959). Path co-efficient analysis allows an effective means of partitioning correlation co-efficients into unidirectional pathway and alternate pathways. This analysis permits a critical examination of specific factors that produce a given correlation and can be successfully employed in formulating an effective selection strategy .

Water is the main abiotic limiting factor in many wheat production areas in the India and especially Kashmir. Due to erratic spatial and temporal distribution of rainfall, it is important to have cultivars with superior yield performance under limiting and non-limiting soil moisture conditions. Thus, the objectives of the study were: i) to estimate the parameters of genetic variability, ii) to evaluate associations of yield components with grain yield and, iii) to determine direct and indirect effects of yield components on grain yield in wheat germplasm grown

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under rainfed conditions of Kashmir Valley of Himalayan.

MATERIALS AND METHODS

The experiments were conducted at the experimental farm of Regional Station of National Bureau of Plant Genetic Resources, Srinagar of Jammu and Kashmir state located in the Himalayan region. The soil is sandy clay type that needs a lot of water to grow plants and water table is very deep. Fertility is constrained by low organic matter. The region has temperate climate characterised by long winter from November to April where temperature goes down upto -9^{0}C. The experimental fields are covered by snow for at least 15-20 days in a year during winter. The rainy season for the region is February to May. Rains are sometimes frequent and sometimes scattered. The experiments were sown in the last week of October during *Rabi* 2007-08, 2008-09 and 2009-10. Experiments were harvested in the month of May. Thus, wheat crop takes almost six months to mature, however, maturity duration varies from genotype to genotype.

The experimental materials comprised of thirty three accessions of wheat, received from the Head, Division of Germplasm Evaluation, National Bureau of Plant Genetic Resources, New Delhi, were sown in a randomized complete block design with three replications. Each plot consisted of three rows of three meters length spaced 15 cm apart. The standard agronomic practices were followed to raise good crop each year. The data were recorded on ten randomly taken plants for seed yield/ plant (g), 1000- seed weight (g), number of spikelets per spike, number of seeds per spike, spike length (cm.), plant height and days to 50 per cent flowering. Analysis of variance, broad sense heritability, genotypic and phenotypic co-efficients of variations, correlation co-efficients and direct and indirect effects were estimated using statistical programme SPAR 2.0 developed by IASRI. The expected genetic advance was calculated according to the formula, Gs=k.ðp.h^2 where, Gs = genetic advance under selection, k= 2.06 (selection differential at 5% selection intensity) ðp= phenotypic standard deviation of the mean performance of base populations and h^2= broad sense heritability.

RESULTS AND DISCUSSION

Mean squares (Table 1) revealed highly significant differences among the genotypes for all the characters under study in all three years indicating the presence of considerable amount of genetic variability for these traits.

Table 2 revealed the results of three years regarding mean, range, phenotypic and genotypic co-efficient of variation, heritability in broad sense and genetic advance expressed as percentage of mean for the traits under study. Moderate phenotypic and genotypic co-efficients of variation were recorded for seed yield per plant, number of spikelets per spike, number of seeds per spike, plant height and days to 50 per cent flowering (Empilli *et al*., 1995; Uddin *et al.*, 1997; Sharma *et al*., 1998; Rama *et al*., 1999; Thakur *et al.*, 1990; Zaharieva *et al*., 2003). However, low value of PCV was estimated for 1000-seed weight and spike length (Wang *et al.*, 1998; Kamboj *et al*., 2000 and Ali Firouzian *et al*., 2003) . Heritability in broad sense was estimated high for seed yield per plant, 1000-seed weight, number of spikelets per spike, number of seeds per spike, spike length, plant height (Nirmala and Jha, 1998; Wang *et al*., 1998; Shah, 1998; Thakur *et al*., 1990; Rama *et al*., 1999; Kamboj *et al*., 2000; Mahesh *et al*., 2001; Ali-Firouzian *et al*., 2003; Mohammad and Hussain, 2004). Whereas, moderate heritability was estimated for days to 50 per cent flowering . The higher magnitude of heritability for most of the studied traits indicated the presence of large heritable variance in the germplasm of wheat. The heritability value alone provides no indication of the amount of genetic progress that would result in selecting the best individual, but heritability estimates along with the genetic advance is considered more useful.

The genetic advance expressed as percentage of mean (using 5% selection intensity) revealed variable behaviour of the traits. It is worth mentioning that genotypes involved in

Table 1: Mean squares for studied traits of wheat germplasm

SOV flowering	years	Seed yield /Plant (g)	1000-seed weight (g)	No. of spikelets /spike	No. of seeds /spike	spike length	Plant height	Days to 50%
Genotypes	2007-08	7.967*	0.263*	21.752*	145.173*	8.127*	88.234 *	9.867*
	2008-09	32.228*	0.580*	19.726*	184.995*	8.263*	95.365*	10.002*
	2009-10	39.178*	0.462*	18.986*	187.866*	8.765*	89.236*	11.563*
Replications	2007-08	1.864	0.013	2.463	34.722	4.105	17.897	3.293
	2008-09	1.979	0.015	2.643	36.638	4.119	22.845	3.998
	2009-10	1.773	0.012	2.098	36.698	3.897	20.362	3.871
Error	2007-08	1.083	0.004	0.996	15.635	1.675	10.873	1.674
	2008-09	1.138	0.004	1.089	15.733	1.780	11.265	2.094
	2009-10	1.074	0.005	1.368	15.846	1.803	10.365	2.886

* Indicate significance of value at P=0.05

combination of high heritability and high genetic advance under selection inherited favourable genes for these traits indicating that the traits are more amenable to selection and could be improved by simple method. The results of present study revealed high heritability associated with high genetic advance in case of seed yield per plant, 1000-seed weight and spike length (Dixit, 1990; Shah, 1998; Thakur *et al*., 1990 and Rama *et al*., 1999) indicating that additive gene effects are important in determining these characters. Number of spikelets per spike, number of seeds per spike and plant height showed high heritability (Dixit, 1990; Singh *et al*., 1996) with moderate genetic advance indicating the chance of effective selection of these traits for improvement. Days to 50 per cent flowering displayed medium heritability with similar pattern of genetic advance (Dixit, 1990 and Singh *et al*., 1996) thus non-additive (dominance/epistasis) gene effects were more important for these traits.

Correlation co-efficients among all pairs of variables estimated for the years 2007-08, 2008-09 and 2009-10 are presented in Table 3. In general, correlation co-efficients at genotypic level were higher than those at phenotypic level in most of the cases. It might be due to depressing effects of environment on characters associations (Paroda and Joshi, 1970 and Ahmad *et al*., 1978). Number of spikelets per spike, number of seeds per spike, spike length and days to 50 per cent flowering were positively and significantly associated with seed yield per plant (Nayeem *et al*., 2003) during all three years. Days to 50 per cent flowering had exhibited positive and significant associations with number of spikelets per spike and number of seeds per spike. However, number of spikelets per spike exhibited negative and significant correlation with number of seeds per spike in all three years.

Direct and indirect effects of characters on seed yield are presented in Table 4. Number of seeds per spike, number of spikelets per spike, spike length, 1000- seed weight and days to 50 per cent flowering had exhibited large direct effects on seed yield (Narwal, 1999) during all three years. Number of spikelets per spike via number of seeds per spike, spike length, and plant height; number of seeds per spike via spike length and plant height and days to 50 per cent flowering via number of seeds per spikelet had exerted positive indirect effects on seed yield. Negative indirect effect was exerted by 1000-seed weight via plant height; number of seeds per spike via 1000-seed weight and plant height via number of seeds per spikelets on seed yield.

Results of the study showed that the existing genetic variability in the germplasm may provide good source of materials for wheat breeding programme. During segregating generations selection should be done in favour of number of spikelets per spike, number of seeds per spike, spike length,

Table 2: Estimate of mean, range, phenotypic and genotypic coefficients of variation, heritability and genetic advance in wheat germplasm

Characters	years	Mean	Range	PCV	GCV	Heritability	Genetic advance
Seed yield/ plant (g)	2007-08	14.77	5.84-24.72	16.11	15.23	67.81	24.15
	2008-09	16.02	5.38-27.61	18.39	17.32	64.15	23.67
	2009-10	15.28	5.71-26.37	17.36	16.88	70.36	24.85
1000-seed weight (g)	2007-08	4.74	2.43-5.74	13.63	13.27	71.83	26.35
	2008-09	4.83	2.55-5.72	13.84	13.15	78.34	29.64
	2009-10	4.70	2.49-5.48	14.55	14.47	74.24	28.17
No. of spikelet / spike	2007-08	17.82	14.25- 22.34	22.59	21.37	55.14	17.63
	2008-09	18.27	14.44- 22.57	25.57	25.16	56.67	17.94
	2009-10	18.39	14.65- 22.88	24.97	24.67	59.43	18.75
No. of seeds / spike	2007-08	42.55	28.98-55.62	22.39	21.39	57.24	18.46
	2008-09	43.37	28.86-56.26	21.65	21.31	52.37	16.39
	2009-10	44.36	28.38-58.88	21.91	21.03	62.86	17.47
Spike length	2007-08	9.98	7.10-13.30	13.71	12.89	73.43	26.85
	2008-09	9.45	7.00-13.34	13.48	12.81	71.65	26.37
	2009-10	10.05	7.05-13.65	13.76	12.24	74.23	27.06
Plant height (cm.)	2007-08	79.48	68.37-95.85	31.76	30.90	58.99	19.02
	2008-09	78.25	67.10-96.70	31.57	30.72	67.84	23.89
	2009-10	78.55	69.45-96.98	31.12	30.30	64.23	17.17
Days to 50% flowering	2007-08	180.23	171-193	17.35	16.96	42.47	15.31
	2008-09	180.58	174-194	15.84	15.23	35.65	14.13
	2009-10	180.31	173-192	16.58	15.93	37.24	14.88

Table 3 : Correlation coefficients of seed yield with other traits in wheat germplasm

Characters flowering	years	Seed yield /plant (g)	1000-seed weight (g)	No. of spikelets /spike	No. of seeds /spike	spike length	Plant height	Days to 50%
Seed yield/ plant (g)	2007-08	1.00	0.21	0.60*	0.53*	0.44*	-0.25	0.48*
	2008-09	1.00	0.11	0.67*	0.42*	0.30	-0.20	0.52*
	2009-10	1.00	0.15	0.77*	0.43*	0.37*	-0.20	0.47*
1000-seed weight (g)	2007-08	0.23	1.00	0.21	-0.22	0.10	-0.20	0.35
	2008-09	0.14	1.00	-0.07	-0.10	0.14	-0.10	0.29
	2009-10	0.17	1.00	0.21	0.03	0.16	-0.13	0.37*
No. of spikelet/ spike	2007-08	0.66	0.24	1.00	-0.63*	0.23	-0.02	0.53*
	2008-09	0.72	-0.06	1.00	-0.44*	0.27	-0.05	0.51*
	2009-10	0.71	0.23	1.00	-0.65*	0.25	-0.10	0.53*
No. of seeds /spike	2007-08	0.56	0.23	-0.35	1.00	-0.23	-0.1	0.43*
	2008-09	0.44	0.12	-0.40	1.00	-0.22	-0.11	0.42*
	2009-10	0.55	0.16	-0.45	1.00	- 0.12	-0.13	0.38*
Spike length (cm)	2007-08	0.47	0.20	0.39	0.23	1.00	-0.15	0.29
	2008-09	0.44	0.24	0.37	0.18	1.00	-0.16	0.32
	2009-10	0.41	0.21	0.35	0.13	1.00	-0.13	0.31
Plant height	2007-08	-0.05	-0.07	-0.07	-0.05	-0.07	1.00	0.32
	2008-09	-0.10	-0.04	-0.15	-0.04	- 0.06	1.00	0.34
	2009-10	-0.10	0.00	-0.18	-0.05	-0.03	1.00	0.30
Days to 50% flowering	2007-08	0.49	0.38	0.43	0.53	0.33	0.35	1.00
	2008-09	0.56	0.42	0.46	0.52	0.39	0.38	1.00
	2009-10	0.51	0.47	0.41	0.53	0.34	0.36	1.00

Table 4 : Direct and indirect effects of factors influencing seed yield

Characters	Years	1000-seed Weight	Spikelets/ spike	Seeds/ spike	Spike length	Pl.height	Days to 50% flowering	Correlation
1000-seed weight	2007-08	0.2414	-0.0223	0.0811	-0.0821	-0.1151	0.1113	0.21
	2008-09	0.1852	-0.0231	0.1053	-0.1551	-0.1313	0.1321	0.11
	2009-10	0.2065	-0.0301	0.0819	-0.0904	-0.0984	0.0853	0.15
Spikelets/ spike	2007-08	-0.0741	0.2582	0.1521	0.1818	0.1743	-0.0815	0.61
	2008-09	-0.0936	0.2821	0.1789	0.1691	0.1951	-0.0621	0.67
	2009-10	-0.0688	0.2939	0.2372	0.1802	0.2305	-0.0993	0.77
seeds/ spike	2007-08	-0.0996	-0.0959	0.3001	0.1209	0.2041	0.1015	0.53
	2008-09	-0.1284	-0.0937	0.2806	0.0935	0.1809	0.0912	0.42
	2009-10	-0.1302	-0.0886	0.2954	0.1137	0.1467	0.0882	0.43
Spike length	2007-08	-0.0434	0.0132	0.1204	0.2964	-0.0416	0.0994	0.44
	2008-09	-0.0524	0.0198	0.0987	0.2648	-0.0408	0.0713	0.36
	2009-10	-0.0606	0.0134	0.0929	0.2727	-0.0511	0.0987	0.37
Plant height	2007-08	0.0046	-0.0972	-0.1405	-0.0213	0.0962	-0.0941	-0.25
	2008-09	0.0034	-0.0707	-0.1279	-0.0122	0.0889	-0.0964	-0.21
	2009-10	0.0043	-0.0732	-0.1103	-0.0198	0.0601	-0.0882	-0.23
Days to 50% flowering	2007-08	0.0234	0.1002	0.1718	0.0772	-0.0327	0.1376	0.48
	2008-09	0.0208	0.0913	0.1759	0.0981	-0.0272	0.1642	0.52
	2009-10	0.0229	0.0989	0.1591	0.0783	-0.0388	0.1461	0.47

and delayed flowering. The higher 1000-seed weight will also be helpful indirectly to improve seed yield.

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