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Research Note

Variability, heritability and genetic advance for quantitative characters in hexaploid wheat (*Triticum aestivum* L.)

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Abstract:
Thirteen diverse wheat lines were crossed with three well adapted varieties as testers in a line X tester design. Thirty-nine F_1's and 16 parental lines were evaluated in a Randomized Block Design (RBD) with three replications. Observations were recorded on ten quantitative traits *viz.* days to heading, days to maturity, plant height, tillers per plant, spike length, grains per ear, 1000-grain weight, biological yield per plant, grain yield per plant and harvest index. Sufficient genetic variability was observed for all ten characters studied. All the characters exhibited high heritability except plant height and grains per ear. Biological yield per plant, tillers per plant and grain yield per plant had high heritability coupled with high genetic advance thereby indicating that selection for these characters would be effective.

Key words: Wheat, variability, heritability and genetic advance

At present world population is about seven billion and is growing at the rate of one billion every fourteen years. India is second most populous country with more than one billion people. Food grains requirement of India is estimated to be 250 million tones by 2025. Present availability of food grains is 206.4 million tones. Therefore, our prime target is to produce more food grain to ensure food security. Wheat is the second most important cereal crop of India grown under diverse agro climatic conditions, with the production of about 72.00 million tones from an area of 26.50 million hectares with productivity of 2.72 tones per hectare in 2005-06. About 90 per cent of the total wheat production is contributed by five states *viz*. U.P., Punjab, Haryana, M.P., and Rajasthan (www.fac.usda.gov). Wheat cultivation in India spans between 10°N in peninsular India and 35 °N latitude in the foothills (Tandan and Sethi (1987)**.** India contributes significantly in total wheat production that made India second largest wheat producing country at global level. Productivity in North Western Plain Zone (NWPZ) has reached to stagnation. Therefore, effective efforts are required to be made to break the yield barriers and to achieve a quantum jump in grain yield. Biometrical and genetical advances have provided several approaches for the genetic analysis of quantitative characters. One of the techniques, line x tester analysis has been proved to be a useful tool for screening the lines with rapidity and reasonable degree of confidence particularly where larger numbers of genotypes are to be evaluated. Heritability estimates and genetic advance are important genetic parameters. The knowledge of heritability coupled with expected genetic advance for a trait will help us in deciding the scope of improvement of that particular trait through selection. Expected genetic advance indicates the expected genetic progress for particular trait under selection cycles and measures the extent of its stability under selection pressure.

Keeping these points in view the present investigation was undertaken to study the experimental material consisting of 39 F1's generated by cross of thirteen genetically diverse promising genotypes viz., HD 2285, MP 1190, PBW 502, UP 2338, HD 2643, HD 2687, Raj 3765, HD 2329, Sangam, WCW 98-20, WCW 98-15, WCW 98-37 and WCW 98-40 with well adapted 3 testers, i.e. UP 2425, PBW 373 and PBW 435 of wheat (*Triticum aestivum* L.) in a line x tester design.

The experiment was laid out in a Randomized Block Design (RBD) with three replications. All the 39 F1s along with 16 parents were evaluated. Each entry was planted in one-meter long single row plot. The rows were spaced 23 cm apart. The plant-to-plant distance was maintained at 10 cm by proper thinning. Observations on most of the 10 characters viz., were recorded on single plant basis except for days to heading and days to maturity. Five competitive plants from each plot were randomly selected for recording observations on

single plant basis. Average data from selected plants in respect of different characters were used for statistical analysis. The analyses of heritability and genetic advance were carried out as per the methods suggested (Falconer, 1967; Johnson *et al*., 1955).

The analysis of variance for all the ten characters namely days to heading, days to maturity, plant height, tiller per plant, spike length, grains per ear, 1000-grain weight, biological yield per plant and harvest index was carried out following Randomized Block Design analysis. Analysis of variance (Table-1) for ten characters indicated that the genotypes used in the present studies were significantly different. Days to heading ranged from 83.00 to 97.33 days with a general mean of 88.53 days. Coefficient of variation calculated for this character was 0.97. Days to maturity ranged from 113.67 to 136.00 days with a general mean of 128.02 days. Coefficient of variation calculated for this character was 0.92. Plant height ranged from 63.20 to 78.40 cm with a general mean of 70.18 cm. Coefficient of variation calculated for this character was found to be 3.37. Tillers per plant ranged from 9.80 to 18.63 with a general mean of 12.75. Coefficient of variation calculated for this character was 6.48. Spike length ranged from 9.00 to 18.63 cm among different genotypes with a general mean of 11.98 cm. Coefficient of variation calculated for this character was 5.85. Grains per ear ranged from 45.73 to 58.77 with a general mean of 51.80. Coefficient of variation calculated for this character was 6.21. The 1000-grain weight ranged from 44.43 to 58.77 g with a general mean of 52.48 g. Coefficient of variation calculated for this character was 4.12. Biological yield per plant ranged from 39.60 to 74.33 g with a general mean of 54.58 g. Coefficient of variation calculated for this character was 3.80. Grain yield per plant ranged from 20.53 to 35.33 g with a general mean of 28.22 g. Coefficient of variation calculated for this character was 6.62. Harvest index ranged from 40.81 to 66.24 per cent with a general mean of 54.32 per cent. Coefficient of variation calculated for this character was 4.78.Heritability was calculated for all the characters studied (Table-2). Out of these, eight characters showed high heritability whereas plant height and grains per ear showed moderate heritability (56.34 and 44.56%, respectively). Days to maturity had the highest heritability (93.95%) followed by biological yield (93.84%), days to heading (93.37%), 1000 grain weight (81.40%), tiller per plant (80.22%), harvest index (79.87%), grain yield per plant (79.23%) and spike length (70.99%). Genetic advance is presented for all the characters (Table 1). Biological yield per plant had the highest genetic advance (29.60%) followed by tillers per plant (24.07%), grain yield per plant (23.70%). The 1000-grain weight (16.02%) and spike length (15.87%) had the moderate genetic advance, whereas harvest index (8.26. %), grains per ear (7.77%), days to heading (7.27%), days to maturity (7.20%) and plant height (5.92%) had low genetic advance (Table-2).

In the present investigation all the characters had high heritability except plant height and grains per ear for which moderate heritability was observed. Days to maturity had the highest heritability followed by biological yield per plant, days to heading, 1000 grain weight, tillers per plant, harvest index, grain yield per plant, spike length and plant height while total number of grains per ear had the lowest heritability. Similar findings have been reported (Mahmood and Shahid, 1991; Amin *et al*., 1992; Awaad, 1996; Li *et al*., 2003; Safeer *et al*., 2004; Khan *et al*., 2005). Habitability is a property of not only a character but also of the population, environment and the circumstances to which the genotypes are subjected. Its ultimate value depends upon the magnitude of all components of variance. Variation in traits with high heritability estimates in the present material was probably due to genetic effects of higher order. Additive genetic advance seems to be responsible for high heritability; if so, early generation selection for such characters is expected to yield better results. High heritability with high genetic advance for some of these traits has also been reported earlier (Gupta *et al*., 2004). For plant height and grains per ear, which had low genetic advance and moderate heritability, the direct selection might not be effective.

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Table 1 Analysis of variance, heritability and genetic advance for 10 characters in parents and F_1 generation of wheat

Source of variation	df.	Days to heading	Days to maturity	Plant height (cm)	Tillers per plant	Spike length (cm)	Grains per ear	1000-grain weight (g)	Biological yield/plant (g)	Grain yield/ plant (g)	Harvest index (%)
Replication	2	0.91	4.65	42.07	0.11	0.17	84.13	4.97	3.94	13.20	1.84
Genotype	54	32.13**	65.54**	26.27**	8.98**	4.09**	35.32**	66.14**	201.14**	43.42**	86.38**
Error	108	0.74	1.37	5.59	0.68	0.49	10.34	4.68	4.30	3.49	6.69
SEm±		0.49	0.68	1.37	0.48	0.40	1.86	1.25	1.19	1.08	1.49
CV%		0.97	0.92	3.37	6.48	5.85	6.21	4.12	3.80	6.62	4.78
Grand mean		88.53	128.02	70.18	12.75	11.98	51.80	52.48	54.58	28.22	54.32
Range		83.00-97.33	113.67-136.00	63.20-78.40	9.80-18.63	9.00-18.63	45.73-58.77	44.43-58.77	39.60-74.33	20.53-35.33	40.81-66.24
Heritability (%)		93.37	93.95	56.34	80.22	70.99	44.56	81.40	93.84	79.23	79.87
Genetic advance		6.44	9.23	4.16	3.07	1.90	3.97	8.41	16.16	6.69	9.49
Genetic advance (%) over mean		7.27	7.20	5.92	24.07	15.87	7.77	16.02	29.60	23.70	8.26

*****Significant at 1% probability level***

Table 2: Heritability and genetic advance for 10 quantitative characters in wheat

Characters	Heritability (%)	Genetic advance	Genetic advance (%)over mean
Days to heading	93.37	6.44	7.27
Days to maturity	93.95	9.23	7.20
Plant height (cm)	56.34	4.16	5.92
Spike length (cm)	70.99	1.90	15.87
Tillers per plant	80.22	3.07	24.07
1000-grain weight (g)	81.40	8.41	16.03
Grains per ear	44.56	3.97	7.77
Biological yield per plant (g)	93.84	16.16	29.60
Harvest index (%)	79.87	9.49	8.26
Grain yield per plant (g)	79.22	6.69	23.70