Genetic Variability, Character Association and Path Analysis of Yield and its Component Characters in Six-rowed Barley

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Genetic variability, character association and path analysis between yield and its component traits were carried out in 55 genotypes of six-rowed barley (*Hordeum vulgare* L.). Highly significant differences between genotypes were recorded for all the characters studied. High phenotypic and genotypic coefficient of variation coupled with high heritability and high genetic advance in grain yield/plant and moderate for grains/spike, spikelets/spike, tillers/plant, flag leaf area and plant height. Correlation and path coefficient analysis revealed that harvest index, tillers/plant, grains/spike and 1000-grain weight, were the most important characters for realizing improvement in grain yield in six-rowed barley.

Key Words: Barley, GCV, Genetic Variability, PCV, Path Analysis

Development of high yielding cultivars requires knowledge of the existing genetic variation and also the extent of association among yield contributing characters. The observed variability is a combined estimate of genetic and environmental causes of which only the former one is heritable. However, the estimate of heritability alone does not provide an idea of the expected gain in the next generation but it has to be considered in conjunction with genetic advance. Correlation and path analysis will establish the extent of association between yield and its component and also bring out the relative importance of their direct and indirect effects and, thus, give a clear understanding of their association with yield. The present study deals with the above genetic constant and character association in 55 genotypes of six-rowed barley.

Materials and Methods

Fifty five genotypes including 10 parents and 45 F_1s of six-rowed barley were grown in a randomized block design with three replications in three environments (date of sowing) at the Research Farm Asalpur, SKN College of Agriculture, Jobner, Jaipur, during *rabi* 2000-01. Observations were recorded on 10 random plants/genotype in each replication and environment separately for 10 quantitative characters, namely, days to heading, plant height (cm), tillers/plant, flag leaf area, spike length, spikelets/spike, grainyield/plant (g). The data were pooled and standard statistical procedures followed for estimating genetic components, phenotypic and genotypic coefficient of variation (Burton, 1952), heritability (Hanson *et al.*, 1956) and genetic advance (Johnson *et al.*, 1955). Genotypic and phenotypic correlation coefficients were calculated following Searle (1961) and path analysis following the method of Dewey and Lu (1955).

Results and Discussion

A wide range of phenotypic variability was observed for all the characters studied. The analysis of variance recorded highly significant differences between genotypes for all the characters studied. This suggested that there is considerable amount of inter-varietal variability in six-rowed barley.

The data on yield and its contributing traits, genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability (h^2_{bs}) and genetic advance (GA) are presented in Table 1. The variability estimates, in general, revealed that the phenotypic variation (PCV) was higher than the corresponding genotypic variance (GCV) for different characters though the extent of difference between the two was relatively low. The estimates of PCV and GCV indicated the existence of fairly high degree of variability for grain yield/plant. Moderate variability was observed for tillers/plant, plant height, grains/spike, spikelets/spike and flag leaf area. Relatively low PCV and GCV were recorded for spike length, 1000-grain weight, days to heading and harvest index. The genotypic coefficient of variation ranged from a minimum of 3.44% for harvest index to a maximum 21.44% for grain yield/plant. The grain yield/plant showed the highest PCV value of 21.74 in comparison to GCV of 21.44

Table 1. Data on mean, range and genetic parameter in 55 genotypes of six-rowed barley

Characters	Mean	Range	GCV (%)	PCV (%)	GA	h^2 (bs) (%)
Days to heading	82.03	70.33 - 92.33	4.38	5.15	6.24	72.20
Plant height (cm)	74.25	61.31 - 99.32	10.47	12.00	13.94	76.00
Tillers/plant	7.14	5.40 - 8.87	10.62	11.48	1.41	85.50
Flag leaf area	6.70	5.63 - 8.25	7.39	8.54	0.92	74.90
Spike length	7.87	6.31 - 8.96	6.48	8.11	0.83	63.80
Spikekets/spike	51.07	42.31 - 60.60	7.79	8.45	7.49	85.00
Grains/spike	48.39	39.38 - 57.63	8.24	8.82	7.61	87.30
1000-grain weight	48.58	41.71 - 55.43	5.13	5.36	4.91	91.80
Harvest index	40.07	36.29 - 43.48	3.44	3.81	2.54	81.50
Grain yield	15.64	9.87 - 24.78	21.44	21.74	6.70	97.20

suggesting less environmental influence on this character, which was confirmed by its high heritability. The difference between PCV and GCV was minimum for 1000-grain weight, grain yield/plant, harvest index, grains/spike and spikelets/spike suggesting that these traits were least affected by environment. This observation draws support from the very high value of heritability (>81.50) recorded for these traits (Table 1). The observations are in agreement with the findings of Arbi *et al.* (1992).

Grain yield of a crop is the result of interaction of a number of inter-related characters. Therefore, selection should be based on these component characters after assessing their correlation with grain yield. Character associations revealed the mutual relationship between two characters, and it is an important parameter for taking a decision regarding the nature of selection to be followed for improvement in the crop under study. In the present investigation, grain yield/plant was found to be significantly and positively correlated with harvest index, tillers/plant, spikelets/spike, grains/spike, spike length, 1000-grain weight and flag leaf area (Table 2). Therefore, these characters should be considered while making selection for yield improvement in barley. Harvest index showed positive and highly significant correlations with tillers/plant, spike length, spikelets/spike, grains/spike, flag leaf area and 1000-grain weight at both

Table 2. Phenotypic (P) and genotypic (G) correlation coefficient among 10 characters in six-rowed barley

Characters		Plant Height	Tillers/ plant	Flag leaf area	Spike length	Spikelets/ spike	Grains/ spike	1000-grain weight	Harvest index	Grain yield/ plant
Days to	P	0.220	0.102	-0.085	-0.048	0.032	0.022	-0.074	0.077	0.062
Heading	G	0.301*	0.132	-0.090	-0.011	0.031	0.009	-0.098	0.133	0.081
Plant height	P		0.271*	0.027	0.160	0.118	0.129	-0.176	0.151	0.161
	G		0.361**	0.073	0.237	0.154	0.157	-0.202	0.170	0.180
Tillers/	P			0.675**	0.565**	0.616**	0.613**	0.329*	0.807**	0.844**
Plant	G			0.777**	0.775**	0.701**	0.696**	0.363*	0.945**	0.927**
Flag leaf area	P				0.465**	0.491**	0.491**	0.216	0.631**	0.617**
	G				0.637**	0.582**	0.582**	0.267	0.767**	0.724**
Spike length	P					0.695**	0.682**	0.345**	0.642**	0.676**
	G					0.866**	0.855**	0.457**	0.807**	0.842**
Spikelets/	P						0.981**	0.339*	0.718**	0.822**
spike	G						0.999**	0.398**	0.769**	0.868**
Grains/	P							0.347*	0.704**	0.819**
Spike	G							0.405**	0.760**	0.860**
1000-grain	P								0.514**	0.574**
weight	G								0.599**	0.607**
Harvest Index	P									0.905**
	G									0.965**

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

(genotypic and phenotypic) level. On the other hand, 1000-grain weight showed positive and significant correlations with spike length, grains/spike, spikelets/spike and tillers/plant at both levels. Grains/spike showed positive and significant correlations with spikelets/spike, spike length, tillers/plant and flag leaf area, whereas spikelets/spike was positive and significantly correlated with spike length, tillers/plant and flag leaf area. Significant positive correlation of spike length with tillers/plant and flag leaf area; flag leaf area with tillers/plant, tillers/plant with plant height at both levels, whereas plant height with days to heading at genotypes level only (Table 2). Vazquez and Sanchez (1987) also reported similar findings.

Yield is the sum total of the several component characters which directly or indirectly contributed to it. The information derived from the correlation studies indicated only mutual association among the characters. Whereas, path coefficient analysis helps in understanding the magnitude of direct and indirect contribution of each character on the dependent character like grain yield. Partitioning of correlation coefficient into direct and indirect effects provides the information about the nature and magnitude of effects of other characters on grain yield. The results of the present investigation on path coefficient analysis (Table 3) revealed the characters like grains/spike, tillers/plant, 1000-grain weight and days to heading had maximum positive direct effect on grain yield at both the level, while the harvest index, spikelets/spike, plant height and flag leaf area have positive direct effect at phenotypic level whereas spike length has positive direct effect on genotypic level. Spikelets/spike, harvest index, plant height and flag leaf area at genotypic level whereas spike length at phenotypic level had direct but negative effect on grain yield. On the other hand, positive indirect effects on grain yield were realized from characters including grains/spike, 1000-grains weight, harvest index and tillers/plant. The residual effect at genotypic (-0.00002) and phenotypic (0.0591) levels were a very low magnitude, which indicates that variables included in this study were significant.

Table 3. Path coefficient analysis of phenotypic (P) and genotypic (G) correlation coefficient to determine the direct (in bold face) and indirect effects of different traits on grain yield in barley

Characters		Days to heading	Plant height	Tillers/ plant	Flag leaf area	Spike length	Spikelets/ spike	Grains/ spike	1000-grain weight	Harvest index	Correlation with grain yield/plant
Days to heading	P	**0.008**	0.005	0.033	0.000	0.000	0.005	0.004	-0.015	0.022	0.062
	G	**0.127**	-0.050	0.140	0.003	0.000	-0.067	0.022	-0.031	-0.063	0.081
Plant height	P	0.002	**0.023**	0.088	0.000	-0.002	0.020	0.024	-0.036	0.044	0.161
	G	0.038	**-0.166**	0.383	-0.003	0.003	-0.339	0.407	-0.063	-0.081	0.181
Tillers plant	P	0.001	0.006	**0.324**	0.003	-0.006	0.103	0.113	0.068	0.233	0.844**
	G	0.017	-0.060	**1.062**	-0.029	0.009	-1.539	1.802	0.114	-0.449	0.927**
Flag leaf area	P	-0.001	0.001	0.219	**0.004**	-0.005	0.082	0.090	0.045	0.182	0.617**
	G	-0.011	-0.012	0.825	**-0.037**	0.008	-1.276	1.507	0.087	-0.365	0.724**
Spike length	P	0.000	0.004	0.183	0.002	**-0.010**	0.116	0.125	0.071	0.185	0.676**
	G	-0.001	-0.039	0.823	-0.023	**0.012**	-1.901	2.212	0.143	-0.384	0.842**
Spikelets/ spike	P	0.000	0.003	0.200	0.002	-0.007	**0.167**	0.180	0.070	0.207	0.822**
	G	0.004	-0.026	0.744	-0.021	0.010	**-2.195**	2.592	0.125	-0.366	0.868**
Grains/ spike	P	0.000	0.003	0.199	0.002	-0.007	0.164	**0.184**	0.072	0.203	0.819**
	G	0.001	-0.026	0.739	-0.021	0.010	-2.198	**2.589**	0.127	-0.361	0.860**
1000-grain weight	P	-0.001	-0.004	0.107	0.001	-0.003	0.056	0.064	**0.206**	0.148	0.574**
	G	-0.012	0.003	0.386	-0.010	0.005	-0.873	1.049	**0.314**	-0.285	0.607**
Harvest index	P	0.001	0.003	0.262	0.003	-0.006	0.120	0.129	0.106	**0.288**	0.905**
	G	0.017	-0.028	1.004	-0.028	0.010	-1.688	1.968	0.188	**-0.475**	0.965**

Residual, Genotypic = -0.0002, Phenotypic = + 0.0591

** Significant at 1%.

In the light of above findings it may be concluded that improvement in characters like tillers/plant, grains/spike, 1000-grain weight and harvest index will help in improving the grain yield in six-rowed barley both directly and indirectly. Therefore, these characters should be considered for yield improvement in barley breeding programme.

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