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GENETIC VARIABILITY FOR YIELD AND ITS COMPONENTS IN BARLEY (*HORDEUM VULGARE* L.)

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SUMMARY

A total of 21 barley genotypes comprising two and six row type were grown in a randomized block design (RBD) with three replications during **rabi** 2012-13 at CCSHAU Regional Research Station, Bawal (Rewari). The objectives of the investigation were to study genetic variability, correlation and path analysis for 10 characters viz., plant height (cm), ear length (cm), number of tillers per meter row, number of grains per spike, days to heading, days to maturity, 1000-grain weight (g), biological yield (kg/plot), harvest index (%) and grain yield (kg/plot). Significant differences were observed among the genotypes for all the characters studied. The characters, namely, number of grains per spike, number of tillers per meter row, ear length and harvest index showed high range, PCV, GCV, heritability and genetic advance. Genotypic and phenotypic coefficients of variation were highest in number of grains per spike followed by number of tillers per meter row. Estimates of heritability ranged from 54 per cent for biological yield to 98 per cent for number of grains per spike, while grain yield showed 57 per cent heritability. High heritability coupled with high genetic advance as per cent of mean was observed for number of grains per spike, number of tillers per meter row, ear length, harvest index and 1000-grain weight indicating the importance of these traits in selection and crop improvement. The genotypic correlation estimates showed significant positive association of grain yield with harvest index, 1000-grain weight, days for heading and days to maturity. Harvest index and biological yield exhibited the highest positive and significant direct effect on grain yield. Hence, these traits could be considered as suitable selection criteria for the development of high yielding barley varieties.

Key words : Genetic variability, correlation coefficient, path analysis, yield components, barley

Barley (*Hordeum vulgare* L.) is frequently being described as the most cosmopolitan of the crops, grown over the wide environmental range than any other cereal and it has been considered as poor man‘s crop because of its low input requirement and better adaptability to harsh environments, like drought, salinity and alkalinity and marginal lands. Because of its hardiness, in many countries around the world, it is often considered the only possible rainfed cereal crop under low input and stressful environment. Apart from its uses as food and feed, it is also used for malt and brewing.

In order to have good choice of characters for selection of desirable genotypes under planned breeding programme for yield enhancement, the knowledge of nature and magnitude of variability existing in available breeding material, the association of component characters with yield and their exact contribution through direct and indirect effect are very important. The present study was, therefore, undertaken to estimate the genetic variability, association of different characters and their direct and indirect effects on grain yield with a view to identify the genotypes with best potentiality for upgrading yield and its component characters.

MATERIALS AND METHODS

The experimental material consisted of 21 diverse two as well six row type barley genotypes. The material was evaluated in randomized block design with three replications at CCSHAU Regional Research Station, Bawal during **rabi** 2012-13. Each genotype was grown in four rows with a plot size of 5 x 1.38 m^2.

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Recommended package of practices were followed to raise the crop. The observations were recorded for 10 quantitative traits viz., plant height (cm), ear length (cm), number of tillers per meter row, number of grains per spike, days to heading, days to maturity, 1000-grain weight (g), harvest index (%), biological yield (kg/plot) and grain yield (kg/plot). Five randomly selected competitive plants in each replication were recorded for all the traits under study except of days to heading, days to maturity, biological yield and grain yield which were recorded on plot basis. Further, the value of harvest index was calculated as per the formula given by Donald and Humblin (1976).

The mean performance of each genotype was embayed for statistical analysis. Analysis of variance to test the significance for each character was carried out as per methodology given by Panse and Sukhatme (1967). Genotypic and phenotype coefficients of variation (GCV and PCV) were calculated by formula given by Burtan (1952), heritability in broad sense (h^2) by Burtan and Vane (1953) and genetic advance given by Johnson *et al*. (1955). Correlation and path coefficients were worked out as per method suggested by Al-Jibouri *et al.* (1958) and Dewey and Lu (1959), respectively.

RESULTS AND DISCUSSION

Significant differences were observed among the genotypes for all the characters studied indicating considerable amount of variability among them. General mean, range, phenotypic coefficients of variation (PCV), genotypic coefficients of variation (GCV), heritability (broad sense) and genetic advance (% of mean) for all the characters are presented in Table 1. PCV was greater than GCV for all the characters which reflected the influence of environment on the expression of traits. The characters, namely, number of grains per spike, number of tillers per meter row, ear length and harvest index showed high range, PCV, GCV, heritability and genetic advance. However, days to heading and days to maturity exhibited least genotypic and phenotypic coefficients of variation. Phenotypic and genotypic coefficients of variation were highest in number of grains per spike followed by number of tillers per meter row, ear length, harvest index and biological yield indicating availability of sufficient variability and thus exhibited scope for genetic improvement through selection for all these traits. Similar findings were also reported by Singh (2011) in barley.

High heritability in broad sense estimated for all the traits except for yield in which it was moderate. High heritability indicated that the characters were less influenced by the environment. Estimates of heritability ranged from 54 per cent for biological yield to 98 per cent for number of grains per spike, while grain yield showed 57 per cent heritability. The estimates of heritability are more advantageous when expressed in terms of genetic advance. Genetic advance expressed as per cent of mean was highest for number of grains per spike followed by number of tillers per meter row. Other characters showed moderate genetic advance except days to maturity which had low genetic advance. High heritability coupled with high genetic advance was observed for number of grains per spike, number of tillers per meter row, ear length, harvest index and 1000-grain weight indicating the importance of these traits in selection and crop improvement. High heritability for

TABLE 1
Estimates of genetic parameters for different traits in barley

Character	Mean	Range	Coefficients of variation (%)		Heritability (bs)	Genetic advance
			PCV	GCV		
Plant height (cm)	105.85	87.70-123.50	7.39	6.18	70	10.68
Ear length (cm)	7.49	5.50-10.20	13.58	12.16	80	22.41
No. of tillers/meter row	128.03	63.00-225.00	25.75	22.97	80	42.21
No. of grains/spike	30.80	19.90-55.20	35.68	35.33	98	72.06
Days to heading	83.76	78.00-92.00	5.18	5.10	97	10.35
Days to maturity	124.27	121.00-129.00	1.40	1.28	84	2.40
1000-grain weight (g)	46.23	36.10-56.20	10.39	9.95	92	19.62
Harvest index (%)	37.13	26.14-52.00	14.14	11.96	72	20.85
Biological yield (kg/plot)	5.54	4.30-7.45	11.81	8.69	54	13.16
Grain yield (kg/plot)	2.03	1.49-2.58	11.22	8.43	57	13.05

different characters was also reported by Al-Tabbal and Al-Fraihat (2012) and Akanksha *et al.* (2012) in barley. Singh (2011) observed high heritability along with high genetic advance for number of grains per spike, number of tillers per meter row and 1000-grain weight in two-rowed barley.

Information regarding the nature and extent of association of morphological characters would be helpful in developing suitable plant type, in addition to the improvement of yield, a complex character for which direct selection is not effective. The genotypic correlation coefficients among different morphological characters are depicted in Table 2. The genotypic correlation estimates showed significant positive association of grain yield with harvest index, 1000-grain weight, days for heading and days to maturity. Plant height had significant and positive correlation with biological yield and significant negative correlation with harvest index and number of tillers per meter row. However, positive but non-significant correlation was observed for plant height with grain yield. Significant negative relation was observed between biological yield and harvest index. The significant and positive association of harvest index and days to maturity with grain yield in barley was also reported by Verma and Verma (2011) and Al-Tabbal and Al-Fraihat (2012).

Path coefficient provides an effective way of finding direct and indirect sources of correlation. Direct and indirect effects of these components determined on grain yield are presented in Table 3. The results of path coefficient analysis revealed that harvest index (1.76) exerted the highest positive and significant direct effect on grain yield followed by biological yield (0.86). Therefore, these characters could be considered as main

TABLE 2
Estimates of genotypic correlation coefficients among 10 characters in barley

Character	Plant height (cm)	Ear length (cm)	No. of tillers/ meter row	No. of of grains/ spike	Days to heading	Days to maturity	1000-grain weight (g)	Biological yield (kg/plot)	Harvest index (%)	Grain yield (kg/plot)
Plant height (cm)	1.00	0.062	-0.331**	0.159	-0.002	0.078	0.292**	0.326**	-0.300*	0.106
Ear length (cm)		1.00	-0.028	0.193	-0.274*	-0.161	0.002	0.306*	-0.356**	-0.148
No. of tillers/meter row			1.00	-0.306*	0.271*	0.229	-0.239	-0.761**	0.526**	0.008
No. of grains/spike				1.00	0.016	-0.043	-0.533**	0.438**	-0.556**	-0.357**
Days to heading					1.00	0.846**	0.003	0.284*	0.192	0.508**
Days to maturity						1.00	-0.077	0.454**	-0.127	0.265*
1000-grain weight (g)							1.00	0.088	0.369**	0.598**
Biological yield (kg/plot)								1.00	-0.733**	0.125
Harvest index (%)									1.00	0.699**

*,**Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 3
Direct (diagonal) and indirect effects of different characters on grain yield in barley

Character	Plant height (cm)	Ear length (cm)	No. of tillers/ meter row	No. of of grains/ spike	Days to heading	Days to maturity	1000-grain weight (g)	Biological yield (kg/plot)	Harvest index (%)	Grain yield (kg/plot)
Plant height (cm)	0.013	0.001	-0.004	0.002	0.000	0.001	0.004	0.004	-0.004	0.106
Ear length (cm)	0.010	0.155	-0.004	0.030	-0.042	-0.025	0.000	0.047	-0.055	-0.148
No. of tillers/meter row	0.081	0.007	-0.243	0.074	-0.066	-0.056	0.058	0.185	-0.128	0.008
No. of grains/spike	0.020	0.024	-0.038	0.126	0.002	-0.005	-0.067	0.055	-0.070	-0.357**
Days to heading	0.001	0.113	-0.112	-0.007	-0.414	-0.350	-0.001	-0.118	-0.080	0.508**
Days to maturity	0.041	-0.085	0.120	-0.022	0.445	0.526	-0.040	0.239	-0.067	0.265*
1000-grain wt. (g)	-0.024	-0.000	0.019	0.043	-0.000	0.006	-0.081	-0.007	-0.030	0.598**
Biological yield (kg/plot)	0.281	0.263	-0.655	0.377	0.245	0.391	0.076	0.860	-0.0630	0.125
Harvest index (%)	-0.528	-0.626	0.926	-0.979	0.339	-0.224	0.650	-1.291	1.762	0.699**

Residual effect : 0.021.

components for selection in a breeding programme for higher grain yield. Drikvand *et al.* (2011) also reported positive and significant direct effect of harvest index on grain yield in barley.

The indirect effect of harvest index through biological yield and ear length counter balanced the direct effect of harvest index on grain yield. Similarly, the indirect effect of biological yield through number of tillers per meter row and harvest index counter balanced the direct effect of biological yield on grain yield. The lower residual effect (0.021) indicated that most of the variability in grain yield for the genotypes under study has been explained by the independent variables included in the analysis.

Hence, harvest index and biological yield could be considered as suitable selection criteria for the development of high yielding barley varieties.

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