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SHORT COMMUNICATION

ESTIMATION OF GENETIC PARAMETERS AND CHARACTER ASSOCIATION IN BARLEY (*HORDEUM VULGARE* L.) UNDER IRRIGATED CONDITION

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SUMMARY

The present investigation was carried out at Barley Research Area of the Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar during *rabi* 2016-17 to study the genetic parameters and character association for 10 quantitative traits in 87 barley genotypes. Significant genotypic differences were observed for all the traits studied indicating considerable amount of variation among material evaluated for each trait. Most of the traits under investigation exhibited wide range except for days to heading and maturity. Phenotypic and genotypic coefficients of variation were highest in number of grains per spike followed by grain yield, harvest index, number of tillers per meter row and 1000-grain weight. Estimates of heritability ranged from 61.2 per cent for harvest index to 95.5 per cent for number of grains per spike, while grain yield showed 79 per cent heritability. High heritability coupled with high genetic advance was observed for number of grains per spike, number of tillers per meter row, grain yield, 1000-grain weight and biological yield, indicates the importance of these traits in selection and crop improvement. The genotypic correlation estimates showed significant positive association of grain yield with harvest index, biological yield and number of grains per spike while the characters *viz*., days to heading and maturity, plant height and ear length exhibited significant negative correlation with grain yield. Harvest index and biological yield exerted the highest positive and significant direct effect on grain yield. Therefore, these characters could be considered as main components for selection in a breeding program for higher grain yield.

Key words : Genetic parameters, correlation coefficient, path analysis, barley

Barley (*Hordeum vulgare* L.), a member of the grass family, is a major cereal grain grown in temperate climates globally. It is self-pollinating, diploid species with 14 chromosomes. It has been used as animal fodder, as a source of fermentable material for beer and certain distilled beverages, and as a component of various health foods. High protein barleys are generally valued for food and feeding, and starchy barley for malting. With the rising demand for beer, the demand for barley is also picking up. Also, more than 90% of the world malt production comes from barley. In many countries around the world, because of its hardiness, it is often considered the only possible rainfed cereal crop under low input and stressful environment. In India, the area under barley is around 0.69 million hectares with the production and productivity of 1.78 million tons and 2580 kg/ha, respectively. Haryana state achieved a productivity level of 3475 kg/ha on 40,000 hectares (Anonymous, 2017).

Information of genetic variability in the genetic system of a particular crop is sought as prerequisite with any crop improvement programme. Although increased grain yield is the ultimate goal of the plant breeders, grain yield itself is a product of interaction of many component traits which influence it directly or indirectly. Therefore, variability existing within each component trait must be exploited by selection to realize maximum gain in grain yield. Correlation and path coefficient analysis together give a clear cut picture of interrelationship and relative contribution of independent characters on dependent variable which enables a plant breeder to apply suitable selection procedures for crop improvement. This study was therefore, conducted to estimate the genetic parameters, correlation and path coefficients among barley genotypes to determine criteria for selection that could be effectively used to identify the desirable genotypes with high yield potential.

The experimental material consisted of 87 diverse genotypes including 47 two rowed and 40 six rowed barley. The material was evaluated in randomized block design with three replications at Barley Research Area of the Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar during *rabi* 2016-17. Each genotype was grown in six rows with a plot size of 5 x 1.38 m^2. Recommended package of practices were followed to raise the good crop. The observations were recorded for 10 quantitative traits *viz*., days to heading, days to maturity, plant height (cm), ear length (cm), number of tillers per meter row, number of grains per spike, 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 as 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.

Significant differences were observed among the genotypes for all the character 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 indicates the influence of environment on the expression of traits under study. Most of the traits under investigation exhibited wide range except for days to heading and maturity. Phenotypic and genotypic coefficients of variation were highest in number of grains per spike followed by grain yield, harvest index, number of tillers per meter row and 1000-grain weight indicating availability of sufficient variability and thus exhibited scope for genetic improvement through selection for all these traits. However, biological yield, days to heading and maturity exhibited least genotypic and phenotypic coefficients of variation. Similar findings were also reported by Addisu and Shumet (2015), Kumar *et al.* (2013) except for biological yield, Singh *et al.* (2015), Yadav *et al*. (2015) in barley.

High heritability in broad sense estimated for all the traits except for ear length and harvest index in which it was moderate. High heritability indicated that the characters were less influenced by the environmental effects. Estimates of heritability ranged from 61.2 per cent for harvest index to 95.5 per cent for number of grains per spike, while grain yield showed 79 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 and grain yield. Two characters namely, days to

TABLE 1

Estimates of mean, coefficient of variation, heritability and genetic advance for different characters in barley

Characters	Mean±SE (d)	Range	Coefficients of variation (%)		Heritability (bs) (%)	Genetic advance (% mean)
			PCV	GCV		
Days to heading	81.78±0.91	76.0-88.0	3.71	3.44	86.4	6.59
Days to maturity	122.65±1.01	118.0-128.0	2.17	1.92	78.4	3.51
Plant height (cm)	101.81±2.71	73.0-125.0	10.39	9.86	90.1	19.30
Ear length (cm)	6.66±0.37	5.3-8.1	11.69	9.51	66.2	15.94
No. of tillers per meter row	112.41 ± 5.27	76.0-150.0	19.15	18.27	91.0	35.90
No. of grains per spike	43.02 ± 3.45	21.0-76.0	46.44	45.39	95.5	71.38
1000-grain wt. (g)	46.24 ± 1.42	31.9-62.1	15.28	14.81	93.9	29.57
Biological yield (kg/plot)	8.42 ± 0.55	5.6-12.0	2.04	1.58	77.6	27.10
Harvest index (%)	28.39 ± 3.12	20.22-42.75	21.59	16.88	61.2	27.21
Grain yield (kg/plot)	2.36 ± 0.19	1.36-3.60	21.81	19.39	79.0	35.50

maturity and heading exhibited lowest genetic advance. High heritability coupled with high genetic advance was observed for number of grains per spike, number of tillers per meter row, grain yield, 1000-grain weight and biological yield, indicates the importance of these traits in selection and crop improvement. High heritability for different characters was also reported by Kumar *et al.* (2013) and Singh *et al.* (2014) in barley. Kumar *et al.* (2013) observed high heritability along with high genetic advance for number of grains per spike and number of tillers per meter row in barley. High heritability for different characters was also reported by Yadav *et al.* (2014) in barley except for days to maturity and number of tillers per plant.

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 estimates of genotypic correlation coefficients among different characters are depicted in Table 2. The genotypic correlation estimates showed significant positive association of grain yield with harvest index, biological yield and number of grains per spike while the characters *viz.*, days to heading and maturity, plant height and ear length exhibited significant negative correlation with grain yield. Similarly, positive and significant correlation was found for plant height with days to maturity, ear length, 1000-grain weight and biological yield; days to heading with maturity, ear length and number of grains per spike; ear length with number of tillers per meter row; 1000-grain weight with plant height and number of tillers per meter row, thereby indicating that these traits may be improved simultaneously. Some researchers reported significant positive correlation of grain yield with grains per spike (Yadav *et al.*, 2015); plant height with days to maturity, spike length and 1000-grain weight; tillers per plant with 1000-grain weight; days to heading with maturity; grain yield with grains per spike (Singh *et al.*, 2015);

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

Characters	Days to heading	Days to maturity	Plant height (cm)	Ear length (cm)	No. of tillers/ meter row	No. of grains/ spike	1000-grain weight (g)	Biological yield (kg/plot)	Harvest index	Grain yield (kg/plot)
Days to heading	1.000	0.576**	0.044	0.180**	-0.076	0.162**	-0.279**	0.014	-0.179**	-0.163**
Days to maturity		1.000	0.370**	0.075	-0.124*	0.159**	-0.056	0.013	-0.200**	-0.154*
Plant height (cm)			1.000	0.294**	-0.021	-0.097	0.294**	0.189**	-0.477**	-0.214**
Ear length (cm)				1.000	0.144*	-0.098	0.120	-0.083	-0.184**	-0.239**
No. of tillers per meter row					1.000	-0.812**	0.580**	0.076	-0.129*	-0.041
No. of grains per spike						1.000	-0.739**	0.030	0.182**	0.175**
1000-grain wt. (g)							1.000	0.016	-0.115	-0.056
Biological yield (kg/plot)								1.000	-0.254**	0.592**
Harvest index (%)									1.000	0.619**
Grain yield (kg/plot)										1.000

*, ** Significant at 0.05 and 0.01 level, respectively.

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

Characters	Days to heading	Days to maturity	Plant height (cm)	Ear length (cm)	No. of tillers/ meter row	No. of grains/ spike	1000-grain weight (g)	Biological yield (kg/plot)	Harvest index	Grain yield (kg/plot)
Days to heading	-0.0132	-0.0076	-0.0006	-0.0024	0.0010	-0.0021	0.0037	-0.0002	0.0024	-0.163**
Days to maturity	-0.0048	-0.0083	-0.0031	-0.0006	0.0010	-0.0013	0.0005	-0.0001	0.0017	-0.154*
Plant height (cm)	0.0018	0.0149	0.0403	0.0119	-0.0009	-0.0039	0.0119	0.0076	-0.0193	-0.214**
Ear length (cm)	-0.0063	-0.0027	-0.0103	-0.0352	-0.0051	0.0035	-0.0042	0.0029	0.0065	-0.239**
No. of tillers/meter row	-0.0035	-0.0058	-0.0010	0.0067	0.0465	-0.0378	0.0270	0.0035	-0.0060	-0.041
No. of grains/spike	0.0124	0.0122	-0.0074	-0.0075	-0.0623	0.0768	-0.0568	0.0023	0.0140	0.175**
1000-grain wt. (g)	-0.0126	-0.0025	0.0133	0.0054	0.0262	-0.0334	0.0452	0.0007	-0.0052	-0.056
Biological yield (kg/plot)	0.0113	0.0104	0.1480	-0.0655	0.0595	0.0233	0.0122	0.7851	-0.1995	0.592**
Harvest index (%)	-0.1477	-0.1651	-0.3935	-0.1513	-0.1066	0.1501	-0.0950	-0.2095	0.8243	0.619**

Residual effect : 0.013; rg=genotypic correlation; *, **Significant at 0.05 and 0.01 level, respectively.

harvest index with grain yield; plant height with 1000-grain weight and biological yield (Kumar *et al.*, 2013).

The significant and negative association observed for plant height, ear length and biological yield with harvest index; days to heading with 1000-grain weight and harvest index; days to maturity with number of tillers per meter row and harvest index; number of tillers per meter row with number of grains per spike and harvest index. The negative association of grain yield with days to heading and maturity suggest that early heading and maturing genotypes may result in higher grain yield. These finding are in agreement with the results of Kumar *et al*. (2013) for significant negative relation of plant height with harvest index; grains per spike with number of tillers per meter row and 1000-grain weight; biological yield with harvest index. The significant negative association of grain yield with days to heading, and tillers per plant with days to maturity and grains per spike was also report by Singh *et al*., 2015.

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 (0.824) exerted the highest positive and significant direct effect on grain yield followed by biological yield (0.785). Therefore, these characters could be considered as main components for selection in a breeding program for higher grain yield. These results corroborates with the findings of Kumar *et al.* (2013) and Singh *et al.* (2014). However, days to heading, days to maturity and ear length had negative direct effect on grain yield. Number of grains per spike being significant and positive correlated with grain yield, showed low positive direct effect but also contributed toward grain yield *via* harvest index. Drikvand *et al.* (2011) also reported positive and significant direct effect of harvest index on grain yield in barley. The positive direct effect of grains per spike on grain yield was also report by Yadav *et al.* (2015). The low residual effect (0.013) 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.

Therefore, it can be concluded from present investigation that harvest index and biological yield are the most important yield contributing traits and due emphasis should be given to these traits for genetic improvement of grain yield in barley.

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