Society for Advancement of Wheat and Barley Research
ICAR-Indian Institute of Wheat & Barley Research
Karnal - 132 001, India

Wheat and Barley Research
10(3): 236-239
Short Communication
Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Selection parameters in six rowed exotic barley (*Hordeum vulgare* L.) genotypes

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*** Part of M.Sc. Ag. Thesis submitted to C.S.A. University of Agric. & Tech. Kanpur during 2016*

Article History: Received: 05 Oct., 2018; Revised: 21 Dec., 2018, Accepted: 24 Dec., 2018

Citation: Gupta PK, A Pandey, J Kumar and J Bahar. 2018. Selection parameters in six rowed exotic barley (*Hordeum vulgare* L.) genotypes. *Wheat and Barley Research* **10**(3): 236-239. doi.org/ *10.25174/2249-4065/2018/83754*

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Keywords: Barley, selection parameters, heritability, genetic advance, Correlation

Barley is one of the founder crops of the old world agriculture and one of the first domesticated cereals. Barley ranks fourth in world cereals crop production and used as feed for animals, food for human, malt for industrial use, bedding and cover material of hut roof. It has immense potential as quality cereal especially for nutrition and medicinal point of view. Barley contains eight essential amino acids and beta glucan (soluble fibre) which regulates the blood sugar and provides low cholesterol deposition property similar to oats. It possesses high degree of tolerance to drought and salinity. Selection is the corner stone of plant breeding which operates on existing variability. If variability is high, we can get better results on selection. Only the heritable portion of variability is transmitted to the next generation and is known as heritability. Heritability and genetic advance help in selection of elite types and predicting the gain under selection. The experimental material consisted of 70 six rowed genotypes of exotic barley lines collected from Barley Integrated Gene Management Programme, Toluca, Mexico. These genotypes were planted at Nawabganj Farm, Kanpur in Randomized Block Design with three replications during *Rabi* 2014-15. Each plot consisted of two rows of 3.0m length with a spacing of 5 cm between plants and 30cm between rows. All the recommended agricultural practices were followed to raise a good crop. Data were recorded on three randomly selected plants from each replication on fifteen characters *viz.* days to 50% flowering , days to maturity, number of productive tillers/ plant, plant height, main spike length, number of grains/ spike, grain weight/spike, 1000-grain weight, biological yield/plant, harvest index, grain yield/plant, shoot length, root length, seedling length and seedling dry weight. The data recorded were subjected to various statistical analyses suggested by various research workers such as analysis of variance (Panse and Sukhatme, 1967), GCV, PCV, and ECV (Burton and de Vane, 1953), heritability in broad sense (Hanson *et al*, 1956), genetic advance in percent of mean (Johnson *et al*, 1955) and correlation co-efficient (Searle, 1961). Analysis of variance (Table-1) showed significant differences among the genotypes for all the traits. Replication and error differences were not significant indicating that environmental effects were not prominent. Genotypic and phenotypic co-efficient

Table 1. ANOVA for 15 characters in 70 genotypes of exotic barley

Source of variation	Degrees of freedom	Days to 50% flowering	Days to maturity	Productive tillers/plant	Plant height	Main spike length	Grains/ spike
Replication	2	0.05	4.41	0.99	17.33	0.01	4.80
Genotypes	69	34.26**	22.93**	2.83**	105.43**	0.18**	22.64**
Error	138	1.89	2.47	1.22	16.59	0.06	8.82

of variation (Table-2) were higher for 1000 grain weight, plant height, productive tillers/plant, shoot length, root length, seedling length and seedling dry weight indicating sufficient scope for improvement in these traits through selection. Raikwar *et al.* (2014) and Singh *et al* (2014) also reported the same results in their studies.

Table 2. Phenotypic correlaton coefficient in 9 genotypes of barley

Grain weight/ spike	Biological yield/plant	Grain yield/plant	Harvest index	1000 grain weight	Shoot length	Root length	Seedling length	Seedling dry weight
0.000	7.39	2.34	3.8	1.26	0.58	0.77	0.38	0.030
0.003**	31.09**	4.96**	9.68**	9.43**	3.06**	2.56**	3.56**	0.096**
0.001	6.85	1.23	3.84	4.50	0.89	0.88	1.37	0.038

The portion of heritable and fixable variation can be obtained through heritability and genetic advance estimates. Heritability alone does not provide ample evidence regarding the genetic improvement which could be possible through selection. If heritability is mainly due to additive gene effect then the value of genetic gain would be high. Estimates of heritability and genetic advance were estimated for all the traits and have been presented in Table-3.

Table 3. General mean and genetic variability parameters for fifteen characters in seventy genotypes of exotic barley

SN	Character	General mean	GCV (%)	PCV (%)	ECV (%)	h2 (Broad sense)	Genetic advance (%)	Genetic advance (% over mean)
1	Days to 50% flowering	87.07	3.77	4.09	1.58	85.08	7.99	9.19
2	Days to maturity	137.28	1.90	2.22	1.14	73.35	5.90	4.30
3	Productive tillers/plant	7.53	9.71	17.62	14.71	30.34	1.06	14.12
4	Plant height (cm)	75.80	7.18	8.97	5.37	64.09	11.50	15.17
5	Main spike length (cm)	5.24	3.79	6.19	4.89	37.52	0.32	6.13
6	Grains/spike	46.09	4.65	7.95	6.45	34.31	3.31	7.20
7	Grain wt./spike (g)	1.46	2.04	3.04	2.25	45.31	0.05	3.63
8	Biological yield/plant (g)	28.09	10.12	13.75	9.32	54.12	5.52	19.65
9	Grain yield/plant (g)	12.14	9.17	12.96	9.16	50.05	2.08	17.13
10	Harvest index (%)	43.31	2.96	5.72	4.90	26.70	1.74	4.03
11	1000 grain weight (g)	11.91	2.12	3.17	2.35	44.88	1.50	3.75
12	Shoot length (cm)	10.42	7.17	11.52	9.02	38.74	1.23	11.78
13	Root length (cm)	12.21	6.99	11.87	9.60	34.66	1.32	10.87
14	Seedling length (cm)	22.62	5.78	9.43	7.45	37.56	2.11	9.35
15	Seedling dry weight (mg)	263.15	5.30	9.14	7.45	33.58	21.34	8.11

High heritability (>60%) and low genetic advance (<10%) for days to 50% flowering and high heritability but moderate genetic advance (10-20%) were observed for days to maturity and plant height. Medium heritability (40-60%) and low genetic advance were recorded for grain weight/spike and 1000 grain weight. Other traits showed low heritability values (<40%) and low genetic advance as percent of mean and indicated non additive gene effects, therefore selection would not be effective for these traits. Abdel-Ghani (2013) and Shoaib *et al* (2014) also reported high heritability for all the traits studied. Correlation measures degree and direction of relationship between two traits. If change in one value of trait occurs then the value of other trait would also change. Thus correlation determines how these characters are associated with the efficiency of selection for the success of any breeding programme. The knowledge of correlation among yield and its contributing traits help the plant breeders in improving the efficiency of selection. The correlation coefficients were estimated for all the characters with grain yield/plant and among the characters themselves both at genotypic and phenotypic levels (Table-4). Grain yield/ plant had highly significant and positive correlation with biological yield/plant, plant height, number of productive tillers/plant while it showed significant positive correlation with number of grains/spike, shoot length and main spike length at phenotypic level but significant negative correlation with days to 50% flowering. At genotypic level

Table 4. Phenotypic (upper diagonal) and genotypic (lower diagonal) correlation coefficients for fifteen characters in seventy genotypes of exotic barley

SN	Characters	Days to 50% flowering	Days to maturity	Tillers/ plant	Plant height	Length of main spike	Grains/ spike	Grain weight/ spike	Bio. Yield (g)	Harvest index	1000 grain wt.	Shoot length	Root length	Seedling length	Seedling dry wt.	Grain yield/ Plant
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Days to 50% lowering	1.000	0.515**	0.069	-0.288	-0.270	-0.027	0.145	0.388	0.114	0.207	-0.405	-0.348	-0.456	-0.361	-0.378*
2	Days to maturity	0.496**	1.000	0.175	0.113	-0.085	0.101	0.286*	-0.151	0.237*	0.056	-0.114	-0.199	-0.198	-0.113	-0.088
3	Tillers/plant	0.004	0.098	1.000	0.318**	-0.019	0.190	0.204	0.278*	0.258*	-0.035	-0.260	-0.029	-0.191	-0.163	0.401**
4	Plant height	-0.198	0.093	0.087	1.000	0.135	0.435**	0.375**	0.600**	0.058	0.015	0.066	-0.134	-0.039	-0.151	0.680**
5	Length of main spike	-0.138	-0.036	-0.260	0.120	1.000	0.307**	0.062	0.399**	-0.423*	-0.198	0.605**	0.221	0.493**	0.385**	0.300*
6	Grains/spike	0.013	0.054	0.045	0.271	0.694**	1.000	0.834**	0.223	0.041	0.029	0.053	-0.148	-0.070	-0.102	0.287*
7	Grain weight/ spike	0.115	0.168	0.088	0.257	0.538**	0.885**	1.000	0.141	0.066	-0.042	-0.153	-0.242	-0.250	-0.236	0.213
8	Biological Yield	-0.240	-0.072	0.031	0.547**	0.219	0.133	0.104	1.000	-0.412	0.007	0.345**	0.065	0.232*	0.120	0.956**
9	Harvesting index	0.040	0.061	0.134	-0.024	-0.087	0.066	0.090	-0.322	1.000	-0.059	0.303**	-0.040	-0.208	-0.177	-0.130
10	1000 Grain weight	0.076	-0.128	-0.018	0.004	-0.080	-0.015	-0.026	0.034	-0.069	1.000	0.025	0.257*	0.172	0.187	-0.027
11	Shoot length	-0.232	-0.085	-0.070	0.041	0.203	-0.017	-0.107	0.233*	0.092	0.062	1.000	0.345**	0.789**	0.676**	0.270*
12	Root length	-0.183	-0.120	-0.047	-0.035	0.163	0.004	-0.005	0.035	0.088	0.082	0.255	1.000	0.848**	0.870**	0.057
13	seedling length	-0.263	-0.135	-0.065	0.002	0.227	-0.007	-0.093	0.151	0.006	0.090	0.757**	0.829**	1.000	0.948**	0.180
14	seedling length	-0.196	-0.097	-0.064	-0.060	0.180	-0.016	-0.073	0.092	0.013	0.105	0.699	0.814*	0.957**	1.000	0.074
15	Grain yield/ plant	-0.239	-0.053	0.588**	0.565**	0.192	0.581**	0.565**	0.908**	0.086	0.308**	0.196	0.075	0.158	0.010	1.000

* = SIGNIFICANT AT 5% ** = SIGNIFICANT AT 1%

grain yield/plant exhibited highly significant positive correlation with number of tillers/plant, plant height, grains/spike, grain weight/spike, biological yield/plant and 1000 grain weight. Ali *et al* (2009) and Singh *et al* (2014) also reported similar findings in their study.

Summary

An experiment involving 70 genotypes of exotic barley was conducted during *Rabi* 2014-15 at Crop Research Farm, Nawabganj, Kanpur in Randomized Block Design with three replications. Data were recorded and analysed for 15 characters viz. days to 50% flowering, days to maturity, number of productive tillers/plant, plant height, main spike length, number of grains/spike, grain weight/ spike, 1000-grain weight, biological yield/plant, harvest index, grain yield/plant, shoot length, root length, seedling length and seedling dry weight. The analysis of variance showed significant differences among genotypes for all the traits. High estimates of genotypic coefficient of variability were observed for biological yield/plant, plant height, number of productive tillers/plant, grain yield/plant, plant height and shoot length. High values of heritability were recorded for days to 50% flowering, days to maturity and plant height, while moderate heritability estimates were recorded for grain weight/spike, biological yield/plant, grain yield/plant and 1000-grain weight, while moderate genetic advance was recorded for plant height. Rest of the traits showed low genetic advance. Highly significant positive correlation of grain yield/plant was observed with biological yield/plant, number of productive tillers/plant, main spike length, while significant positive correlations were observed with number of grains/spike and shoot length

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