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Genetic variability and correlation analysis of yield and its contributing traits in barley (*Hordeum vulgare* L.) for drought tolerance

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Abstract

The experimental material comprised of 25 most diverse genotypes along with 2 checks varieties were sown in randomized block design with four replications in both rainfed and irrigated environment. Significant variations were revealed for all the characters under study. High GCV and PCV were observed for peduncle length followed by number of grain per ear and grain yield per plant under both environments. The estimates of broad sense heritability was highest for number of grain per ear, plant height, peduncle length and flag leaf length in irrigated environment, while in rainfed environment it was highest for peduncle length, plant height, flag leaf length and 1000 grain weight. Positive and significant association was shown by grain yield per plant with plant height, flag leaf length, flag leaf width and number of grains per ear. Path coefficient analysis revealed direct high positive effect on number of grains per ear, 1000 grain weight, flag leaf width and number of effective tillers per plant.

Key words: Barley, drought tolerance, heritability, correlation

Introduction

Barley (*Hordeum vulgare* L.) is one of the founder crops of Old World agriculture and has fourth rank among the major food grains. The global acreage and production of barley is 58.69 million ha and 150 million tonnes respectively, with an average yield potential of 2540 kg per ha. The important countries growing this crop are European union, Russia, Ukrain, Canada, Australia, Turkey and USA. India ranked 21st position in area and 18th position in production (FAO 2013-14). Barley has a bright future as salinity resistant and dual purpose crop for green forage and grain, and also in the form of regenerate crop, especially in arid region. Looking the global warming situation barley has a hope as edge crop to sustain the food security. Barley is an important winter cereal crop in the northern plains of India. It is primarily grown as a rain-fed crop in poor marginal soils of the states. The growing area and production of barley in the country has now stabilized in the last few years with minor fluctuation depending on the demand and price situation as well as weather condition. During rabi, 2013-14 about 1730 thousand tonnes of barley has been produced with 25.5 q/ha average productivity in 671thousand hectares. Among the states, Rajasthan and Uttar Pradesh leads in both area and production while Punjab has an edge over other states in terms of average yield followed by Haryana and Uttar Pradesh.

Till date availability of desirable genotypes with better yielding is not completely satisfactory. Hence effort is being made to develop the desirable genotype which also can be adopted in various range of environmental stress; it is the ultimate goal of plant breeders (Sabaghpour et al., 2003). This can be possible only when we select the desirable genotypes and traits to be transferred. Also the studies on genetic variability for yield and yield contributing traits and direct and indirect contribution of important yield components towards grain yield as well as to identify the characters of utmost importance that may be used as selection criteria will be of great significance in a barley breeding programme. Identifying and understanding mechanisms of drought tolerance is crucial to the development of tolerant commercial cultivars. Thus, the responses of plants to various stresses have for decades been the focus of physiological and molecular studies (Levitt 1980). In view of above fact the present investigation was undertaken.

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Materials and methods

Twenty five genotypes derived from different crosses were used as test genotypes along with two checks (Lakhan and Jyoti). These genotypes were developed and maintained by All India Co-ordinated Barley Improvement Project. The present investigation was conducted during the rabi season at the Agriculture Research Farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The experiment was laid out in Randomized Block Design with four replications. Each entry was sown with a six row of 5 meter length with row to row spacing of 25 cm and plant to plant spacing of 10 cm. Recommended package of all agronomic practices were followed to raise a good crop. Ten competitively plants were selected randomly for recording the data on yield and its contributing traits viz., days to 50 percent heading, days to maturity, plant height, number of effective tillers per plant, flag leaf length, flag leaf width, peduncle length, spike length with awn, number of grains per spike, grain yield per plant and 1000 grain weight. The mean data of each plot was used for statistical analysis.

Genotypic and phenotypic coefficients of variation were estimated as per Burton (1952). The broad sense heritability and genetic advance as percent of mean were calculated as proposed by Johnson *et al.* (1955). Correlation coefficient were estimated using the variance and covariance components as given by Miller et al (1958). and path coefficient analysis was estimated according to the method suggested by Dewey and Lu (1959).

Results and discussion

The analysis of variance indicated highly significant difference among the genotypes for all the eleven characters studied in both the environment. Highest estimate of genotypic and phenotypic coefficient of variance was noted for peduncle length, grain yield per plant, and number of grains per ear in both irrigated and rainfed environments. Hence, these traits could be utilized for selection programme. Similar results were also reported by Shahinnia *et al.* (2005), Mishra *et al.* (2008), Singh *et al.* (2008) and Jalata *et al.* (2011). Heritability in broad sense was high for grains per ear, plant height, peduncle length, flag leaf length and 1000 grain weight. These finding was in accordance with Singh *et al.* (2006), Mohammadii *et al.* (2006), Pal *et al.* (2010), and Eshghi *et al.* (2011). High heritability coupled with high genetic advance as percent of mean were observed for peduncle length, number of grains per ear, grain yield per plant and leaf length. Mishra et al. (2007), Singh *et al.* (2008), Eshghi *et al.* (2011) and Jalata *et al.* (2011) also reported similar result which supported the present finding (Table 1).

Correlation coefficient under irrigated condition with grain yield per plant exhibit positive and significant correlation with plant height, flag leaf length, flag leaf width, number of grains per ear and 1000 grain weight. Hence selection of one or more of these traits would improve the grain yield per plant. These result were consonance with Al-Nashash *et al.* (2005), Singh *et al.* (2006), Pal *et al.* (2010) and Nikkhah *et al.* (2010). While for rainfed condition grain yield per plant showed positive and significant correlation with plant height, peduncle length, ear length, flag leaf length, flag leaf width, number of effective tillers per plant, number of grains per ear, 1000 grain weight and days to 50 percent flowering. These results are in conformity with the findings of Ataei et al. (2006), Singh et al. (2007) and Nikkhah *et al.* (2010) (Table 2). Path coefficient analysis revealed that grain yield per plant was directly influenced by number of grains per ear, 1000 grain weight, flag leaf width and number of effective tillers per plant in irrigated and Plant height, number of grains per ear, number of effective tillers per plant, days to 50 percent flowering and peduncle length in rainfed condition. Kara (2008), Mittal et al. (2009), Eshghi et al. (2011) and Zaefizadeh et al. (2011) also found the similar results (Table 3).

Table 1. Genetic parameter for yield and its component traits

S. No.	Character	Mean		Range		PCV		GCV		Heritability in broad sense %		Genetic advance as % of mean	
		Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated
1	Days to75% heading	76.22	80.85	72.2-79.7	77.2-84.7	2.83	2.41	5.56	2.13	81.92	77.95	4.77	3.87
2	Days to Maturity	105.09	111.66	101.2-113.5	108.2-116.2	2.80	2.13	2.52	1.81	80.98	71.98	4.67	3.16
3	Plant Height(cm)	83.46	103.22	63.8-117.4	78.7-128.9	13.98	10.98	13.87	10.92	98.47	98.91	28.36	22.36
4	Peduncle length (cm)	7.89	10.01	1.3-13.6	3.5-16.3	45.46	36.30	45.24	35.92	99.01	97.95	92.74	73.24
5	Ear length(cm)	17.35	19.02	14.5-20.4	15.3-22.6	10.07	8.71	8.76	6.91	75.65	62.77	15.70	11.27
6	Flag leaf length(cm)	9.76	13.96	7.1-11.8	10.6-18.6	18.64	12.96	15.46	15.05	97.99	96.75	37.64	30.48
7	Flag leaf width (cm)	1.17	1.50	0.8-1.3	1.2-1.9	16.83	16.45	14.84	13.13	77.78	63.75	26.97	21.60
8	No. of effective tiller/plant	4.08	4.58	3.3-4.7	3.9-5.1	9.87	6.97	9.03	5.62	83.73	65.10	17.02	9.35
9	No. Of grains/ear	51.62	58.61	22.8-63.0	27.1-76.7	24.15	24.52	23.36	24.46	93.58	99.61	46.56	50.30
10	1000 grain weight(g)	48.08	51.06	40.8-54.2	41.8-59.2	7.31	8.49	7.18	8.33	96.43	96.25	14.52	16.84
11	Grain yield/plant(g)	5.97	7.66	3.4-9.7	4.1-11.04	25.46	24.17	22.71	22.40	79.59	85.89	41.74	42.77

Table 2. Correlation coefficient analysis for yield and its components

Charecters	Environments	Plant Height (cm)	Peduncle length (cm)	Ear Length (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Eeffective tiller/plant	No. Of grains/ ear	1000 grain weight (g)	Days to75% heading	Days to maturity	Grain yield/ plant(g)
Plant Height (cm	Rainfed	1.00	0.638**	0.548**	0.512**	0.537**	0.114	0.336**	0.363**	0.308**	0.533**	0.664**
	Irrigated	1.00	0.269**	0.332**	0.225*	0.213*	-0.002	0.184	0.427**	0.055	0.149	0.275**
Peduncle length (cm)	Rainfed		1.00	0.123	0.353**	0.482**	0.059	0.137	0.219*	0.044	0.229*	0.456**
	Irrigated		1.00	-0.42	0.250*	0.123	-0.166	0.029	0.274**	-0.171	0.009	0.146
Ear length (cm	Rainfed			1.00	0.409**	0.203*	0.016	0.440**	0.160	0.316**	0.463**	0.373**
	Irrigated			1.00	0.159	-0.049	-0.115	0.191*	0.095	0.051	0.206*	0.141
Flag leaf length (cm)	Rainfed				1.00	0.487**	0.272**	0.090	0.352**	0.118	0.274**	0.376**
	Irrigated				1.00	0.486**	0.037	0.354**	0.378**	-0.071	-0.057	0.469**
Flag leaf width (cm)	Rainfed					1.00	0.254*	0.312**	0.019	0.092	0.148	0.401**
	Irrigated					1.00	-0.063	0.505**	0.202*	0.227	0.131	0.544**
Eeffective tiller/plant	Rainfed						1.00	0.159	-0.118	-0.195*	-0.164	0.329**
	Irrigated						1.00	-0.055	-0.025	-0.302**	-0.295**	0.082**
No. Of grains/ ear	Rainfed							1.00	-0.224*	0.101	0.198*	0.475**
	Irrigated							1.00	-0.169	-0.007	-0.006	0.624**
1000 grain weight (g)	Rainfed								1.00	0.156	0.211*	0.198*
	Irrigated								1.00	0.013	0.043	0.269**
Days to75% heading	Rainfed									1.00	0.763**	0.287**
	Irrigated									1.00	0.769**	-0.018
Days to maturity	Rainfed										1.00	0.406**
	Irrigated										1.00	-0.027
Grain yield/plant(g)	Rainfed											1.00
	Irrigated											1.00

Table 3. Path coefficient analysis for yield and its components

Characters	Environ -ments	Plant Height (cm)	Peduncle length (cm)	Ear length (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Eeffective tiller /plant	No. Of grains/ ear	1000 grain weight (g)	Days to75% heading	Days To maturity	Correl-ation (r)
Plant Height (cm	Rainfed	**0.397**	0.086	-0.055	0.009	-0.035	0.032	0.114	0.039	0.050	0.024	0.665
	Irrigated	**-0.036**	0.013	0.013	0.009	0.038	-0.003	0.106	0.136	0.001	-0.006	0.275
Peduncle length (cm)	Rainfed	0.253	**0.135**	-0.012	0.006	-0.031	0.017	0.046	0.024	0.007	0.010	0.456
	Irrigated	-0.009	**0.049**	-0.001	0.010	0.022	-0.023	0.016	0.087	-0.004	-0.001	0.146
Ear length (cm	Rainfed	0.218	0.016	**-0.101**	0.007	-0.013	0.004	0.149	0.017	0.052	0.021	0.372
	Irrigated	-0.012	-0.002	**0.039**	0.006	-0.009	-0.016	0.110	0.030	0.001	-0.008	0.140
Flag leaf length (cm)	Rainfed	0.203	0.047	-0.041	**0.018**	-0.032	0.078	0.030	0.038	0.019	0.012	0.376
	Irrigated	-0.008	0.012	0.006	**0.040**	0.087	0.005	0.204	0.120	-0.001	0.002	0.469
Flag leaf width (cm)	Rainfed	0.213	0.065	-0.020	0.009	**-0.066**	0.070	0.105	0.002	0.015	0.006	0.401
	Irrigated	-0.007	0.006	-0.002	0.019	**0.180**	-0.008	0.292	0.064	0.005	-0.005	0.544
Eeffective tiller/plant	Rainfed	0.045	0.008	-0.001	0.005	-0.016	**0.287**	0.054	-0.013	-0.032	-0.007	0.329
	Irrigated	0.001	-0.008	-0.004	0.001	-0.011	**0.140**	-0.030	-0.007	-0.007	0.011	0.082
No. Of grains/ ear	Rainfed	0.134	0.018	-0.044	0.002	-0.020	0.045	**0.339**	-0.024	0.016	0.009	0.475
	Irrigated	-0.006	0.001	0.007	0.014	0.090	-0.007	**0.578**	-0.054	-0.002	-0.002	0.624
1000 grain weight (g)	Rainfed	0.144	0.029	-0.016	0.006	-0.001	-0.034	-0.076	**0.109**	0.025	0.009	0.198
	Irrigated	-0.015	0.013	0.003	0.015	0.036	-0.003	-0.097	**0.319**	0.003	-0.001	0.269
Days to75% heading	Rainfed	0.012	0.005	-0.032	0.002	-0.006	-0.056	0.034	0.017	**0.164**	0.035	0.287
	Irrigated	-0.002	-0.008	0.002	-0.002	0.040	-0.042	-0.004	0.004	**0.025**	-0.030	-0.018
Days to maturity	Rainfed	0.211	0.031	-0.046	0.005	-0.009	-0.047	0.067	0.023	0.125	**0.045**	0.406
	Irrigated	-0.005	0.004	0.008	-0.002	0.023	-0.041	-0.003	0.013	0.019	**-0.039**	-0.027

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