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Agronomic Performance and Correlation Study in Barley (*Hordeum vulgare* L) Genotypes

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Original Research Article

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Abstract: Genetic variability is necessary for genetic improvement of any crop. The knowledge on available genetic variability and relationships between economic yield and yield associate traits is important to understand and its potential use in breeding programs. The present study was done at research field of Regional Agricultural Research Station (RARS), Dipayal, Doti during winter seasons of 2014/15 and 2015/16 under maize based bariland system to assess the genotypic variability and correlation among yield and yield components. Fifteen barley genotypes including two check varieties were studied in Randomized Complete Block Design with 3 replications in each year. Statistical analysis revealed the presence of significant genetic variability among the tested genotypes for yield and yield attributing traits. On the basis of yield, seed boldness and maturity period genotypes B86152-2-2-2-OK, XVeola-13, COQ/K1/DESC11 were found promising and could be new barley varieties or as serve as parents for use in breeding programmes to develop high yielding varieties. The positive correlation of grain yield with spike length (0.46**), straw yield (0.44**), tillers/m^2 (0.43**), spikes/m^2 (0.29**), plant height (0.26*) and thousand grain weight (0.25*) showed possibility of yield enhancement thought selecting in favour of those traits.

Keywords: Genotype, Correlation, Yield, Barley.

INTRODUCTION

Barley (*Hordeum vulgare L.*) is the fifth important food crops of Nepal. It is cultivated in 28361 ha with 1157 kg/ha national productivity and about 30% barley area lies on the far western region [10]. Barley is staple food for remote and food deficit mountainous area of Nepal. Barley is the most widely grown crop than any other cereal over large environmental ranges, can be grown from terai up to an elevation of 4000 masl. Barley has significance in mountainous agriculture because it mature earlier, require low input, drought tolerant, better yield stability and require fewer heat unit than wheat therefore better fit in the cropping system of mountainous agriculture than wheat. Barley is used to prepare roti, satu, and baby foods. It is valued for its malt quality and used in preparation of alcoholic beverages. It is considered one of the nutritious food as barley is rich in protein, crude fibre, minerals and vitamins. Despite of its importance, barley has been considered neglected and given less priority on its research and development activities in Nepal. The important factors for lower productivity of barley in Nepal are inadequate number of improved varieties, poor soil fertility, drought condition, poor agronomic management and infestation of leaf rust disease.

Selection is a basic tool of plant breeding by which genotypes with high productivity, disease resistance, better quality and climate resilience for a given environment could be developed. Consequently, the improvement in any crop depends largely on exploiting the available genetic variation [1, 4]. However, selection for high yield is made difficult because yield and yield contributing character are quantitative and vary depending on genotypes and environments [5, 13, 15]. In addition the understanding of correlation between yield and yield attributing traits are prime important in finding out the characters which are closely associated with grain yield for direct and indirect selection [2]. So, knowledge on inherent variability and extent of association between yield and yield contributing character need to be known for efficient selection. Therefore this study was conducted to evaluate barley genotypes for growth and yield performance and to find out interrelationship and contribution of different quantitative characters on barley yield improvement.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at Regional Agricultural Research Station, Dipayal, Doti. Geographically, it is situated at 80° 55' east longitude and 29° 15' north latitude and the altitude of this station is 510 masl [12]. In general, the climate is sub-tropical, pre-monsoon period is dry and very hot. Monsoon starts very late in July and it is very erratic. Generally, annual rainfall does not exceed 1000 ml. High solar radiation and wide variation in day and night temperature is the climatic features of the area. Experimental field soil was shallow in depth and porous, sandy loam, slightly acidic with pH 5.5-6.0, low in nitrogen and organic matter i.e. 1-2% and 0.6 % respectively. Because of light texture soil and low organic matter content, the water holding capacity of the soil is very low [12].

Plant materials

Fifteen barley genotypes (Table 1) including two check varieties received from Hill Crops Research Program (HCRP), Dolakah were used for the study.

Table-1: List of barley genotypes used for the study

Seed Source	SN	Genotypes	SN	Genotypes	EN	Genotypes
Hill Crops Research Program (HCRP), Dolakha	1	COQ/K1/DESCII	6	B86122-1-OK-3	11	Bonus
	2	B86152-2-2-2-OK	7	NB 1003-37/1214	12	Local Check
	3	Xveola-12	8	Xveola-13	13	B86099-5-OK
	4	MATICO'S'	9	B86157-1-1-5-0-OK-3	14	LG51/Xveola-5-77
	5	Xveola-28	10	ARUPO'S'/MOY	15	B90K-024-1-1-2OK

Experimental design, treatments and crop management

Experiment was conducted on randomized complete block design in three replication during winter season (Nov. 2014 to April 2015) of 2014/15 and 2015/16. Seed was sown on flat bed @ 100 kg ha^{-1} on 1st week of November. Spacing used was 25 cm between rows and continuous in a row. Individual plot size was 4 m^2 (8 rows of 2 m long). In addition to 5 t FYM, chemical fertilizer @ 30:30:30 $NP_2O_5K_2O$ kg/ha was applied as basal dose during final land preparation and top dressed by 15 kg N/ha at tillering stage. A pre-sowing irrigation was given just before land preparation. Subsequent 2 irrigations were given at booting and dough stage.

Data recording

Observations on days to 50% heading, days to 90% maturity, grain yield, straw yield, 1000 grain weight were recorded on plot basis from central 4 rows. Number of spikes and number of tillers were recorded from 1m^2 area on the centre of the plot. Plant height and spike length were recorded form 10 randomly selected plants from middle row. Grain yield and 1000 grain weight were adjusted at 14% moisture. The straw yield is sun dried for a week and straw yield is recorded.

Data analysis

Analysis of variance and correlation among traits were done by using Genstat 18th edition at 0.05 level of significance. Significance of correlation coefficient was done as proposed by [7].

RESULTS AND DISCUSSION

Agronomic performance

Combine analysis of variances over years for 15 barley genotypes on 9 quantitative traits were presented on Table 2. Performance of genotypes varied significantly due to growing year were observed for days to heading, days to maturity, plant height, number of spikes/m^2 and straw yield while grain yield, thousand grain weight, spike length and number of effective tillers/m^2 were remained statistically non-significant with respect to growing year. This indicates difference on growing environments on two consecutive year significantly effect on the expression traits including days to heading, days to maturity, plant height, number of spikes/m^2 and straw yield. Genotypic differences were found significant for days to heading, days to maturity, effective tiller/m^2, spike length; thousand grain weights and grain yield however non-significant genotypic differences were observed for straw yield, plant height and number of spikes/m^2. These results showed the presence of inherent genetic variability among the genotypes which gives an opportunity for breeders to select most promising genotypes or improve those traits for variety development through selection and hybridization. Significant difference on barley yield and yield attributing traits were also reported by [3, 8, 9, 11, 14]. Moreover, interaction of genotypes and growing year remained non-significant for all traits except days to heading. Significance response for both genotypes and growing years indicated that both environmental conditions and studied genotypes influenced significantly on the performance of yield and yield components of barley. Non-significant interaction between genotypes and years indicating the non distinct role of genotypes over years on the phenotypic expression which indicate the stable performance of among genotypes with respect to growing environments. These findings are in accordance with previous reporting by Al-Tabbal and Al-Fraihat [3] and Jalata *et al*. [6].

Mean yield and yield attributing traits

Mean performance for yield and yield attributing traits of the tested genotypes were presented on Table 2.

Days to 50% heading

Days to 50% heading from date of sowing ranged from 92.2 to 103.2 with trial mean 96.9 days. Genotypes MATICO'S', B86152-2-2-2-ok, XVeola-13 were observed early in heading than standard check variety Bonus while local check was found late took 103.2 days for 50% heading. Existence of variability on days to 50% flowering is confirmed by the genotypic significant for the trait from analysis of variance. Variation on days to flowering was also reported by Lodhi *et al*. [8] and Subedi *et al*. [14].

Days to 90% maturity

Days to 90% maturity from days to sowing ranged from 125.3 to 133 days. MATICO'S' and B86152-2-2-2-ok were observed significantly early maturing genotypes with respect to standard check. Early maturing types can selected as an early type variety or can be used as parent to develop early maturing cultivars. Early maturity with good yield is desirable trait for barley grown in hilly areas as early maturing variety can better fit in the existing cropping system. Analysis of variance table confirmed the existence of genetic variability on evaluated genotypes for days to 90% maturity. Similar results were also obtained by by Al-Tabbal and Al-Fraihat [3], Jalata et al. [6] and Madakemohekar *et al*. [9].

Plant height

Plant height is an important trait for barley as it is directly affect lodging. Tested genotypes didn't differ statistically for plant height which ranged from 81.8 cm to 97.8 cm with trial mean 89.9 cm. Medium plant height is desired in barley due to fertilizer and irrigation responsiveness and lodging resistance. Non-significant difference for the trait reveled absence of genotypic variability among tested genotypes for plant height. This result is in conformity with to the result obtained by Subedi *et al*. [14].

Number of tillers/m^2

No. of effective tillers per unit area is a important yield attributing traits in barley. Genotypic difference was observed in tillering capacity. It ranged from 174.7 to 370.5 with trial mean 228.6 tillers/m^2. Local variety produced highest tillers but it was at par with standard check variety. None of the tested genotypes were found superior in tillering than Bonus. Analysis of variance showed the existence of genetic variability on evaluated genotypes for number of tillers/m^2. In agreement with this finding, variations on number of tillers/m^2 due to genotypes were also reported by Madakemohekar *et al*. [9] and Mohtashami [11].

Number of spikes/m^2

The number of spike per unit area is very important trait in determining yield performance of barley. Difference due to tested genotypes observed statistically non-significant which ranged from 81 to 162.3 with 110.9 trials mean. Non-significant difference for the trait reveled absence genotypic variability among tested genotypes for pod bearing capacity. This result is in conformity with to the result obtained by by Subedi *et al*. [14].

Spike length

It is also an important factor on determining the yield. Spike length ranged from 6.7 cm to 13.3 cm with mean 10.1 cm. Barley genotype X Veola-28 produced significantly higher spike length than Bonus. Analysis of variance showed the existence of genetic variability on evaluated barley genotypes for spike length. Similar reporting previously done by Lodhi *et al*. [8], Madakemohekar *et al*. [9] and Singh *et al*. [13].

Thousand grain weight

The test weight is a very important factor for the determination of crop yield. In the present study, it was ranged from 28.1 to 37.8 g with mean 31.4 g. Bonus was observed bold seeded having highest test weight. Analysis of variance showed the existence of genetic variability on evaluated barley genotypes for thousand grain weight. In agreement with this finding, variations on thousand grain weight due to genotypes were also reported by Al-Tabbal and Al-Fraihat [3], Lodhi *et al*. [8], Madakemohekar *et al*. [9] and Singh *et al*. [13].

Straw Yield

Genotypic difference for straw yield among tested genotypes was found statistically non-significant. Straw yield ranged from 2.7 to 5.2 t/ha. Non-significant difference for the trait reveled absence of genotypic variability among tested genotypes for straw yield. This result is in conformity with to the result obtained by Subedi *et al*. [14].

Grain yield

Grain yield is a function of combined effect of gene controlling yield components, environmental influence on the gene expression and agronomic practices adopted. Therefore any variation or change on genotype and growing environment is liable to bring a change in attained yield. In the present study genotypic difference is observed for achieved grain yield. Genotypes COQ/K1/DESC11, MATICO'S' produced higher yield but these are at par with Bonus kept as a standard check for this study. As early maturity with high yield is desired traits in barley breeding genotypes B86152-2-2-2-OK, XVeola-13, COQ/K1/DESC11 could be selected as new barley varieties. Analysis of variance showed the existence of genetic variability on evaluated barley genotypes for grain yield. In agreement with this finding, variations on grain yield due to genotypes were also reported by Al-Tabbal and Al-Fraihat [3], Lodhi *et al*. [8], Madakemohekar *et al*. [9], Mohtashami [11], Singh *et al*. [13] and Subedi *et al*. [14]. Significant responses of tested genotypes over growing years suggested the environmental influence

on the expression of those traits. However non-significant interaction between genotypes x year for all traits except days to heading showed the stable performance among genotypes. In line with this findings, very similar reporting were made earlier by Al-Tabbal and Al-Fraihat [3] and Jalata *et al*. [6].

Correlation

Correlation coefficient is a measure of the degree association and relationship between variables. It is important in plant breeding as it can be used for indirect selection. The success of plant breeding program depends on effective selection based on the relationship between yield and yield components. The study of correlation between different characters may help the plant breeder to know how the improvement of one character will bring simultaneous changes in other characters. Thus identification of important yield components and their nature and magnitude of association between them and with economic yield is very useful for selecting high yielding varieties with desired traits. Phenotypic correlation between 9 quantitative traits of 15 barley genotypes is presented in Table 3.

Grain yield exhibited significant positive association with plant height, number of tillers/m2, number of spikes/m2, spike length; thousand grain weight and straw yield while non-significant negative associations were observed for days to heading and maturity. The present results indicates that barley plant selected on the basis of higher tillers/m2, higher spikes/m2, high spike length, high thousand grain weight, high straw yield and relatively taller plants will give high yield. In line with this result, Singh *et al*. [13] reported significantly positive association of spike length, number of tillers, plant height and thousand grain weights on barley grain yield. In addition significant positive correlation of plant height, thousand grain weight and number of tillers on grain yield also reported by Al-Tabbal and Al-Fraihat [3] and Lodhi *et al*. [8]. Among yield attributing traits significant positive correlations were observed between straw yield and plant height, straw yield and days to maturity, straw yield and days to heading suggesting that straw yield can be improved by selection in favor of these traits. In contrast significant negative correlations were observed between straw yield and number of spikes/m^2.

Table-2: Mean performance of barley genotypes at Dipayal, Doti in 2014/15 and 2015/16

SN	Genotypes	DH	DM	PH	Tiller	SP	SL	TGW	SY	GY
1	COQ/K1/DESCII	97.2	128.2	82.5	174.7	90.8	10.2	30.8	4.3	2359
2	B86152-2-2-2-OK	92.2	125.3	95.7	232.7	121.8	9.6	29.6	3.6	2089
3	Xveola-12	96.2	128.7	94.3	224.0	113.3	10.6	32.7	4.1	2210
4	MATICO'S'	91.5	125.3	86.2	204.5	89.8	11.2	32.3	3.6	2332
5	Xveola-28	94.8	128.3	97.8	210.0	104.8	13.3	31.1	3.8	2127
6	B86122-1-OK-3	96.8	129.0	85.7	182.2	81.0	7.4	31.4	3.1	1294
7	NB 1003-37/1214	94.0	126.2	88.2	185.7	97.5	6.7	29.1	2.9	1458
8	Xveola-13	92.8	126.5	90.7	239.3	113.3	10.2	30.0	3.8	2177
9	B86157-1-1-5-0-OK-3	98.8	130.5	81.8	183.0	90.7	9.9	33.1	2.7	1699
10	ARUPO'S'/MOY	99.0	130.3	96.8	230.3	121.8	10.9	32.1	3.6	2137
11	Bonus	97.7	130.5	94.2	314.2	162.3	11.6	37.8	5.2	2153
12	Local Check	103.2	133.0	86.8	370.5	161.7	9.6	31.8	3.8	2068
13	B86099-5-OK	100.2	130.5	84.8	222.3	97.7	8.3	30.8	3.0	1445
14	LG51/Xveola-5-77	102.0	132.3	89.5	235.8	121.5	9.4	31.1	4.0	2362
15	B90K-024-1-1-2OK	97.0	130.0	94.2	219.2	94.8	12.0	28.1	3.8	1934
P value	Year	<.001	<.001	<.001	0.150	<.001	0.438	0.082	<.001	0.660
	Genotype	<.001	0.037	0.330	<.001	0.243	<.001	<.001	0.400	0.016
	Y x G	0.01	0.536	0.146	0.742	0.539	0.628	0.541	0.059	0.151
LSD 0.05	Year	1.53	1.75	5.07		22.3			0.38	
	Genotype	4.21	4.79		72.01		1.43	2.21		658.3
	Y x G	5.96								
	Mean	96.9	129.0	89.9	228.6	110.9	10.1	31.4	3.7	1990
	CV %	3.8	3.2	13.4	27.3	47.6	12.3	6.1	29.4	28.6

DH = Days to 50% heading, DM = Days to 90% maturity, PH = Plant height (cm), Tiller = Number of tillers/m^2, SP = Number of spikes/m^2, SL= spike length (cm), TGW = Thousand grain weight (g), SY = Straw yield t/ha, GY = Grain Yield (kg/ha)

Significant positive correlation with thousand grain weight were observed for number of tillers/m2, number of spikes/m2 and spike length. Similarly spike length and number of tiller/m2 and number of spikes/m2 and number of tillers/m2 also showed significant positive correlation suggesting that these traits have important positive contribution on barley grain yield. This result is supported by previous

findings of Madakemohekar *et al*. [9] and Mohtashami [11]. In the present study significant positive correlation were also observed for plant height and days to heading, plant height and maturity, plant height and number of tillers/m2 and between days to heading and maturity while significant negative relationship were observed for spikes/m2 with days to heading, days to maturity and plant height. Significant positive correlation between days to flowering and maturity were reported by Lodhi *et al.* [8] and Mohtashami [11].

Table-3: Phenotypic correlation coefficient among yield and yield attributing traits of barley genotypes

	DH	DM	PH	Tiller	SP	SL	TGW	SY	GY
DH	1.00								
DM	0.80**	1.00							
PH	0.33**	0.49**	1.00						
Tiller	-0.03	-0.05	0.23*	1.00					
SP	-0.50**	-0.69**	-0.32**	0.52**	1.00				
SL	-0.13	-0.03	0.19	0.26*	0.16	1.00			
TGW	-0.04	-0.04	0.02	0.36**	0.24*	0.25*	1.00		
SY	0.42**	0.57**	0.66**	0.16	-0.45**	0.19	0.08	1.00	
GY	-0.09	-0.08	0.26*	0.43**	0.29**	0.46**	0.25*	0.44**	1.00

Values are significant difference at 5 % level of significance (*) and highly significant at 1 % level of significant (**), DH = Days to 50% heading, DM = Days to 90% maturity, PH = Plant height (cm), Tiller = Number of tillers/m^2, SP = Number of spikes/m^2, SL= spike length (cm), TGW = Thousand grain weight (g), SY = Straw yield t/ha, GY = Grain Yield (kg/ha)

CONCLUSION

Genetic variability is necessary for genetic improvement of any crop. The knowledge on available genetic variability and relationships between economic yield and yield associate traits is important to understand and its potential use in breeding programs. The present study concluded on the presence of significant genetic variability among the tested genotypes. Yield and studied yield attributing traits differ significantly with growing years for most of the traits suggest the influence of growing environment on phenotypes of tested genotypes but the non-significant interaction between genotypes and growing years indicated the stable performance of between genotypes. On the basis of yield, seed boldness and maturity period genotypes B86152-2-2-2-OK, XVeola-13, COQ/K1/DESC11 were found promising and could be new barley varieties. Moreover, available genetic variability shows that there is an opportunity to bring desired improvement through selection. Phenotypic correlation revealed that spikes population, tillering capacity, spike length, straw yield, plant height and thousand grain weight are most important components of yield. Therefore, selection based on these yield contributing characters might be fruitful in barley breeding program.

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