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RESEARCH ARTICLE

Association studies of barley genotypes in mid-hill of Nepal

B.P. Bohora[1*], M. Neupane [2] and B.P. Kandel[3]

1. Tribhuvan University, Institute of Agriculture and Animal Science, Lamjung Campus, Nepal

2. Agriculture and Forestry University, Rampur Chitwan

3. Department of Plant Breeding, Post Graduate Program, Institute of Agriculture and Animal Science, Tribhuvan University, Kirtipur, Kathmandu, Nepal

***Corresponding authors email Id: bkandel33@gmail.com**

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Abstract

A field experiment was conducted during winter season of 2016 at research block of Lamjung campus Lamjung to evaluate the effect of different genotypes on growth and yield of barley in mid-hill of Nepal. The experiment was laid out in randomized complete block design (RCBD) involving twelve genotype treatments i.e. B86157-1-1-5-0-oK (T1), B86099-5-oK (T2), B90K-024-1-1-2-oK (T3), CoQ/ KI/ Descii (T4), MATICO 'S' (T5), B86152-2-2-0-oK (T6), ARVPO'S'/MOY (T7), Bonus STD check (T8), Xveola-23 (T9), LG- 51/ XVeola-5-77 (T10), XVeola-12 (T11) and XVeola-15 (T12) and replicated thrice. B86152-2-2-0-oK were found significant in growth, yield attributes and yield of barley. Effective tiller/m^2 (143.3) and grain yield (1657 kg/ha) was obtained maximum with genotype B86152-2-2-0-oK followed by other pipeline varieties and minimum yield was obtained from treatment T4 (629 kg/ha). The genotype B86152-2-2-0-oK had better performance in terms of growth and yield of Mid hill condition. Correlation studied shows that spike length, biomass and straw yield, thousand grain weight and number of grain per spike positive and significant association with grain yield so these traits used for selection for yield improvement program.

Key words: Performance evaluation, Correlation, *Hordeum vulgare*, Varietal trails

Introduction

Barley (*Hordeum vulgare*) is one of the oldest and first domesticated crop, considered to be grown even during the Stone Age (Salamini *et al.,* 2002). Barley is the founder crop which belong to the genus Hordeum in the *Triticaceae* of the grass family i.e. *Poaceae* (*Gramineae*). It is a self pollinated diploid crop with 2n=14. It is a fast growing, cool season, annual grain crop, that could be used as forage as well as, cover crop to improve soil fertility (Ghanbari *et al.*, 2012).. Barley was presumably first used as human food but evolved primarily into a feed, malting and brewing grain due in part to the rise in prominence of wheat and rice. In recent times, about two-thirds of the barley crop has been used for feed, one-third for malting and about 2% directly for food. It ranks fifth among crops in grain production in the world after maize, wheat, rice and soybean (MoAD, 2017/18). Barley is a momentous crop from religious point of view in the Hindu society to worship the god. Barley (*Hordeum vulgare*) is one of the old and essential winter crop for the high mountain areas of the country. Large amount of diversity is observed for barley in the Nepalese high lands. The region is considered as a center of diversity for barley (Witcombe and Gilani, 1979). Barley is cultivated in a wide range of environments in Nepal (Baniya *et al.,* 1997). The area of production of barley production is limited, but it is grown from the terai up to an elevation of 4000 m. It is a staple food crop mainly in the hills and mountains in the west of the country.

Barley, being a tremendous opportunities crop, we are far back regarding its utilization as an industrial crop. In the past decades, several breweries have been established in the country producing a number of beers brands for the local and foreign market. Malt -barley the main ingredient of beer, is however, imported by all these breweries. Barley is mainly used in beverage industries as a raw material. Efforts for the improvement in the quality and the quantity of the production is lacking. Lack of study and research is a major problem regarding this crop. Thus, this study could work as a pivotal work for the development of the crop in the country and also as a base work for the further researches regarding this crop.. Barley, which is a source of dietary fiber, β-glucan, and antioxidants, has been used as a staple food in several areas of the world for centuries (Ames *et al.,* 2006, Mahdi *et al.,* 2008). The history of food uses of barley was recently reviewed (Newman et al., 2006). Traditional barley foods such as roasted barley flour, called tsampa, and roasted puffed barley are widely consumed in Tibet and provide an important source of dietary fibre in diets consisting primarily of animal-based products (Tashi *et al.,* 2002). Barley is now again returning to favor as it is considered the best food for health by nutritionists. It also possesses many nutritional benefits. Its consumption leads to lowering of low density lipoprotein (LDL) cholesterol (hypo-cholesterolemic effect) that reduces the risk of heart diseases and regulates blood sugar level in diabetics. Barley is a rich source of fibers, which makes it a comfortable diet crop for the heart patients. Barley is also an important industrial crop and is increasingly used in the brewing industry. The increasing awareness about health-related benefits and industrial uses of barley may lead to a rise in its production, and this has been supported by the availability of a range of suitable cultivars to growers. Concerted efforts in barley breeding have resulted in enhanced yield and quality to meet the needs of consumers and industry. Knowledge about a better understanding of the barley genome, breeding methods and cultivation technologies is also of vital importance .This research was conducted for development of promising barley variety for mid hil range of Nepal.

Material and method

Twelve barley genotypes were evaluated in the research field of IAAS, Lamjung district situated at western mid-hill of Nepal during winter season in 2016. It is located at latitude of 28.14^{o}N and longitude 84.40^{o}E and an elevation of 750 masl. The experiment was undertaken using randomized complete block design with three replication and twelve genotypes as treatment. Bonos used as standard check. The gross plot size was 6m^2 (3m*3m) with 12 rows of 2m length while the net plot size was 4m^2 (2m*2m) with 8 rows of 2m length. Continuous line sowing by maintaining 25 cm row to row distance was done. FYM was applied during field preparation and urea was applied as basal dose at the rate of 90gm/gross plot i.e. 150kg/ha. All the inter-cultural operations were carried out uniformly when necessary. The experiment was conducted during winter season in rain-fed condition i.e. seed sowing was done during 2016.

The plant observation parameters like plant height, spike length, number of effective and non-effective tillers/ m^2, spike weight, biomass grain yield, straw yield was taken from the net plot area. Microsoft excel and stastical package R were used for entry and analysis of data.

Table 1. List of genotypes used in research

Name of Genotypes
1 Bonus Std check
2 B86152-2-2-0-oK
3 B90K-024-1-1-2-oK
4 XVeola-15
5 ARVPO'S'/MOY
6 B86157-1-1-5-0-oK
7 MATICO 'S'
8 LG- 51/ XVeola-5-77
9 XVeola-12
10 Xveola-23
11 CoQ/KI/Descii
12 B86099-5-oK

Results and discussion

Plant height (cm): The plant height of genotype B86157-1-1-5-0-oK was found to be tallest being 83.73cm followed by XVeola-12 with plant height 82.43cm and were at par. B86099-5-oK had lowest plant height of 75.44cm. M. Sapkota *et al.*, (2016) also reported similar results.

Spike length (cm): Spike length of genotype CoQ/KI/Descii was found to be highest i.e. 20.13cm followed by B86152-2-2-0-oK, ARVPO'S'/MOY and XVeola-15 with spike length 19.77 and 19.57 respectively and were significantly at par. B86099-5-oK had the lowest spike length of 17.30cm. Similar result was reported by Sapkota *et al.*, (2016).

Effective tillers: B86152-2-2-0-oK had maximum number of effective tillers i.e. 143.3 followed by B86157-1-1-5-0-oK and MATICO 'S' with 141.7 and 136.3 effective tillers respectively. They were statistically significantly at par. Xveola-23 had minimum number of effective tillers i.e. 95.3.

Non-effective tillers: Xveola-23 and XVeola-15 had statistically same and maximum number of non- effective tillers i.e. 17.33 followed by B90K-024-1-1-2-oK with 16.67 non-effective tillers and were significantly at par. LG- 51/ XVeola-5-77 had minimum number of non-effective tillers i.e. 6.67.

Table 1 : Analysis of agronomic characteristics of twelve barley genotypes

Genotypes	Plant height(cm)	Spike length(cm)	Effective tillers	Non effective tillers
Bonus Std check	78.02^{bcd}	18.17^{ab}	105.7^{ef}	15.00^{ab}
B86152-2-2-0-oK	75.52^{d}	19.77^{ab}	143.3^{a}	13.33^{ab}
B90K-024-1-1-2-oK	79.86^{abcd}	17.32^{b}	112.0^{cdef}	16.67^{a}
XVeola-15	77.36^{cd}	18.64^{ab}	114.7^{cde}	17.33^{a}
ARVPO'S'/MOY	80.16^{abcd}	19.57^{ab}	108.0^{def}	15.33^{ab}
B86157-1-1-5-0-oK	83.73^{a}	17.39^{b}	143.3^{a}	13.33^{ab}
MATICO 'S'	77.84^{bcd}	17.43^{b}	136.3^{ab}	12.00^{bc}
LG- 51/ XVeola-5-77	80.67^{abc}	17.80^{ab}	116.7^{cd}	12.00^{bc}
XVeola-12	82.43^{ab}	18.05^{ab}	120.3^{c}	9.33^{cd}
Xveola-23	79.16^{abcd}	18.09^{ab}	95.3^{g}	17.33^{a}
CoQ/KI/Descii	75.87^{cd}	20.13^{a}	132.0^{b}	14.67^{ab}
B86099-5-oK	75.44^{d}	17.30^{b}	103.0^{fg}	7.00^{d}
Grand mean	78.84	1.003	119.08	12.69
SEM	1.478	0.759	3.191	1.226
LSD	4.336	0.4090	9.360	3.597
CV%	1.4	6.1	1.9	2.7

Means within the column followed by the same letter (s) do not differ significantly at 0.05 level by DMRT

Spike weight (gm): XVeola-15 had highest spike weight i.e. 1.337gm followed by Xveola-23 and B86157-1-1-5-0-oK with 1.301gm and 1.131gm respectively and were significantly at par. CoQ/KI/Descii had lowest weight of spike i.e. 0.789gm.

Test weight (gm): ARVPO'S'/MOY had highest test weight i.e. 48.73gm and was statistically highly significant and significantly different than other genotypes. It was followed by Bonus STD check and B86152-2-2-0-oK with 39.40gm and 35.46gm test weight and were significantly at par. B86099-5-oK had lowest test weight of 25.70gm. M. Sapkota *et al.*, (2016) also reported similar results.

Grain yield (kg ha^{-1}): The highest grain yield was of B86152-2-2-0-oK i.e. 1657 kg/ha followed by Bonus STD check i.e. 1594 kg ha^{-1} and were significantly at par. XVeola-15 and B86157-1-1-5-0-oK yielded 1238 kg ha^{-1} and 1232 kg ha^{-1} respectively and were significantly at par. Similar grain yield was reported by Sapkota *et al.,* (2016). 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 Lodhi *et al.,* 2015 , Mohtashami, 2015 , Subedi *et al.,* 2013.

Straw yield (kg ha^{-1}): LG- 51/ XVeola-5-77 had highest straw yield of 5461 kg/ha followed by B90K-024-1-1-2-oK, Bonus STD check and ARVPO'S'/MOY with 5261 kg ha^{-1}, 5239 kg ha^{-1} and 5132 kg ha^{-1} respectively and were significantly at par. B86099-5-oK had lowest straw yield of 2984 kg ha^{-1}.

Table 2. Analysis of agronomic characteristics of twelve barley genotypes

Genotypes	Spike weight (g)	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Bonus STD check	1.125^{ab}	39.40^{a}	1594^{a}	5239^{a}
B86152-2-2-0-oK	0.917^{ab}	35.46^{ab}	1657^{a}	4076b^{c}
B90K-024-1-1-2-oK	0.797^{b}	32.53^{abcde}	1156^{bc}	5261^{a}
XVeola-15	1.337^{a}	32.73^{abcde}	1238^{b}	4512^{b}
ARVPO'S'/MOY	0.871^{ab}	48.73*	1034^{cd}	5132^{a}
B86157-1-1-5-0-oK	1.131^{ab}	29.23^{bcde}	1232^{b}	3517^{cde}
MATICO 'S'	0.951^{ab}	34.90^{abc}	1049^{cd}	3951b^{cd}
LG- 51/ XVeola-5-77	0.962^{ab}	26.13^{e}	706^{fg}	5461^{a}
XVeola-12	0.991^{ab}	28.13^{cde}	802^{ef}	4115b^{c}
Xveola-23	1.301^{a}	27.70^{de}	931de	3402de
CoQ/KI/Descii	0.789^{b}	34.43^{abcd}	629^{g}	4205^{b}
B86099-5-oK	0.869^{ab}	25.70^{e}	771^{fg}	2984^{e}
Grand mean	1.003	32.92	1067	4321
SEM	0.1395	2.116	50.3	198.3
LSD	0.4090	6.206	147.5	581.5
CV%	6.1	1.4	1.5	3.9

Means within the column followed by the same letter (s) do not differ significantly at 0.05 level by DMRT

Correlation with grain yield

Grain yield is positive and highly significant corrected with Spike length (0.626**) biomass (0.706**) and straw yield (0.459**) and positive and significant association with thousand grain weight (0.389*) and number of grain per spike (0.370*). Grain yield is positively significant with tiller per plant, plant height, no of effective tiller and weight of spike, however number of non effective tiller is found to be negatively correlated with grain yield. Earlier researcher on barley reported that grain yield is positive and highly significant with Spike length (Adhikari *et al.,* 2018; Shrimali *et al.,* 2017 and Sapkota *et al.,* 2016), straw yield (Adhikari *et al.,* 2018). Kandel *et al.,* (2017) studied on maize and Gautam *et al.,* (2019) studied on rice also reported that thousand grain weight was positively significant associated with grain yield. Chutimanitsakun *et al.,* (2011) and Dahleen et al. (2012). Reported grain yield positively non significant association with grain yield, which is accordance to our findings.

Conclusion

Good amount of variation was observed among the twelve barley genotypes. Traits like spike length, biomass and straw yield, thousand grain weight and number of grain per spike positive and significant association with grain yield so these traits used for selection for yield improvement program. Hence, encouragement of these superior and high yielding varieties among farmers can bring about positive impact in productivity.

Table 4. Correlation among yield and yield components in barley

	TPP	PH	SL	NET	NNET	NGPS	WS	TGW	BM	SY	GY
TPP	1										
PH	.555**	1									
SL	0.197	-0.024	1								
NET	.453**	.502**	0.132	1							
NNET	0.08	-.465**	-0.064	-.356*	1						
NGPS	-0.121	0.057	0.213	0.055	-0.218	1					
WS	0.112	0.031	0.076	-0.084	0.15	.484**	1				
TGW	0.076	0.058	.446**	0.009	0.007	-0.138	-0.193	1			
BM	0.12	.358*	.367*	0.129	-0.04	0.088	0.114	.471**	1		
SY	0.077	0.325	0.193	0.112	-0.027	-0.048	0.051	.425*	.953**	1	
GY	0.173	0.29	.626**	0.116	-0.056	.370*	0.218	.389*	.706**	.459**	1

** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2 tailed)

Where, TPP: PH: plant height,SL: spike length,NET: number of effective tillers/ m^2,NNET: number of non-effective tillers/ m^2,NGPS: spike weight, WS: weight of spike ,TGW:1000 grain weight, BM: biomass, SY: straw yield ,GY: grain yield

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