Genetic diversity of promising lines of barley based on pheno-morphological traits in Ardabil area

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ABSTRACT

To evaluate the genetic diversity in twenty barley genotypes, an experiment based on randomized complete block design with three replications was done at Agriculture Researches Station of Ardabil, Iran in 2009-10. Investigated traits of this study was included days to flowering, plant height, 1000 seed weight, number of infertile tiller, number of seed per spike, harvest index, days to maturity, straw yield and grain yield. The comparison of means indicated that the genotypes 14, 19, 10, 20 and 16 were placed in the superior group from most traits points of views. It had been an indicator of high potential of the genotypes from agronomy and morphological points of views. Therefore, considering the results of mean comparison of the traits, these genotypes can be introduced as the superior genotypes. Factor analysis based on principal component analysis method and varimax rotation indicate that three important factors accounted 87.55% of the total variation among traits. The second factor that accounted for 34.69% of the total variations had a positive relationship with the number of grain spike, grain yield, grain weight 1000 and harvest index. Therefore we introduced the second factor as an effective factor in increasing the grain yield.

Keywords: Barley, agronomic traits, yield components, varimax rotation, promising lines.

INTRODUCTION

Barley (*Hordeum Vulgare*) is one of the oldest cereals cultivating in the world (Babaiy et al., 2011). Barley is the fourth important cereal crop, cultivated successfully in wide range of climates. This crop has potentials for growing under drought and saline conditions. It requires less input such as fertilizer, irrigation, and insecticides. Barley is increasingly being used as cattle feed in the world. The entire barley kernel is used as feed after grinding. Investigation of genetic variations has been conducted using the morphological traits, biochemical and genetically markers (Zaefizadeh et al., 2011). Genetic diversity is the base of plant breeding, which has been caused by natural development, and is one of the important components of biological systems stability. Evaluating genetic diversity in cultivated plants for plant breeding programs and heritable resources protection has a vital usage. Being aware of genetic diversity in plant species is important for selecting parental races in order to obtain suitable hybrids, and prediction

of hybrids especially in the crops that their hybrid has a commercial value (Farahani and Arzani, 2008; Ahmadizadeh et al., 2011a). A logical attitude for categorizing the traits in the sample which contains the above variation as what is seen in the germplasm necessitates the use of multivariable methods like factor analysis. This method is a strong method that has been used to estimate the components of yield, to extract a subset of identical variables, to identify the basic concepts of multivariable data to recognize applied and biological connections among the traits, to reduce a large number of correlative traits to a few number of factors and to explain the correlation among the variables (Zakizadeh et al., 2010). Morphological and agronomic traits have special role to determine the importance of each trait on increasing yield, as well as to use those traits at the breeding programs, which at least lead to improving yield and introducing commercial varieties. Morphological characters include root length, spike number, grain number per spike, 1000 grain weight, awn length (Eskandari and Kazemi, 2010; Ahmadizadeh et al., 2011a,b). Heydari et al. (2006) studied genetic diversity of different traits in 157 lines of double haploid bread wheat indicated that their under-study lines have higher genetic diversity for last internodes length, number of fertile spike per area unit, plant height, number of grain and grain yield per spike in comparison with other traits like grain volume weight, days to maturity, days to heading and days to anthesis. Other studies had shown that the number of grain spike had a predominant importance over kernel weight in defining yield in high latitudes (Peltonen-Sainio et al., 2007) whereas kernel weight was well known as a major yield component, determining final yield in certain Mediterranean environments (Garcia Del Moral et al., 2003). Garavandi and Kahrizi (2010) by evaluating 20 bread wheat genotypes reports that genotypes has higher genetic diversities for grain yield, spike number per square meter, number of seed per spike, spike density and awn length in comparison with other traits. Khayatnezhad et al. (2010) using factor analysis in his studies on durum wheat cultivars showed that the importance of factor coefficients characteristics of total and fertile tillers, main spike length, 1000-seed weight and yield selected genotypes is desirable for dry conditions. Also, Gholamin et al. (2010) showed that the importance of factor coefficients characteristics of fertile tillers, grain weight original lavender, and seed weight and harvest index selected genotypes is desirable for dry conditions. The aims of present study were to evaluate genetic diversity in promising lines of barley in Ardabil area, also using factor analysis for identifying the relationships and structure of yield components.

MATERIAL AND METHODS

The investigation was done at Agriculture Researches Station of Ardabil in 2009-10. Ardabil Researchers Station is located at 12 km to Ardabil road to Khalkhal by 1350 m altitude, semiarid and cold weathers. We studied 17 promising line and three genotypes (control) of barley with three replications. The area of every field was 6 lines with 20 cm space, 6 m length and the area of every field was 7.2 m^2 and harvesting was 6 m^2 which was plant by eliminating of 0.5 m at first and end of every field. Investigated traits of this study included the number of days to flowering, plant height, 1000 seed weight, number of infertile tiller, number of seeds per spike, harvest index, days to maturity, straw yield and grain yield. Factor analysis on base of major factors analysis and varimax rotations was done on the data. Principal components method analysis was used to extract factorial load of matrix and also to estimate the number of factors. Therefore, the factors which had a root bigger than one were selected and were used to factorial coefficients matrix. By means of varimax rotation, rotation was done on the major factorial loads matrix. Also Eigen values, percent variance, variance and cumulative percentage share each of the extracted factors were calculated. Data analyses were carried out using SPSS software.

RESULT AND DISCUSSION

Mean comparison

Rang of days to flowering had between 134.7 (line 20) to 127 days (line 8) in barely genotypes. Total means of days to flowering was 131.15 in 20 lines studied. Lines 19, 2, 3, 10, 12 and 20 had the most days to flowering (Table 1). Significant difference between studied genotypes in plant height showed that demonstrate the presence of genetic diversity among under studied genotypes. Total mean of 1000 grain weight was 34.11. Lines 15 and 6 had the most 1000 grain weight 45.83 and 44.5, respectively. Lines 1 and 20 had the least 1000 grain weight 30.83 and 31.33, respectively. Mean comparison of genotypes, showed that genotypes 7 and 8 had the least fertile tillers. Genotypes 14, 10, 9, 15 and 20 had the most fertile tillers. Total mean of fertile tillers was 3.491. Lines 20 and 15 had the most plant height 102.8 and 101.8, respectively. Lines 8 and 17 had the least plant height 85 and 86, respectively (Table 1). Due to the capacity of tall genotypes for extracting water of soil and the effective role of stored materials in the stem of these genotypes in grain yield under end seasonal drought, produced more performance as compared to short genotypes (Innes et al., 1985).

The highest number of grain per spike was determined in genotypes 19, 16, 14, 12, 10, 9, 4 and 20. Rang of number of grain per spike had between 49.73 (line 14) to 29.63 (line 15) in barely genotypes (Table 1). Total means of number of grain per spike was 41.11 in 20 lines studied. Harvest index as a quantity trait is an indicator of plant efficiency in distributing photosynthetic materials towards the grain, and introducing the genotypes with high harvest index is considered one of the major and important goals of eugenic programs. However, some researchers have reported a low heritability for harvest index (Wang et al., 2002). Rang of harvest index had between 40.95 (line 14) to 32.37 (line 15) in barely genotypes. Total means of harvest index was 38.49 in 20 lines studied. The highest harvest index was determined in genotypes 19, 14 and 20 and genotype 15 had the least harvest index. Rang of days to maturity had between 184.3 (line 18) to 181 days (line 8) in barely genotypes (Table 1). And it showed early on line 8 and line No. 18 the most delayed among lines were evaluated. Total means of days to maturity was 182.68 in 20 lines studied. Genotypes 13, 9, 8 and 19 had the least days to maturity and the highest days to maturity was determined in genotypes 2, 7 and 18. Genotypes 8 had the least straw yield and the highest straw yield was determined in genotypes 15 and 14 (Table 1).

Significant differences between genotypes in grain yield showed the genetic variation between studied genotypes. This variation can be used in breeding programs to develop high yielding varieties. Genotypes 14, 19, 10, 20 and 16 had the most grain yield. Genotypes 8 had the least grain yield (Table 1). Genotypes 14, 19, 10, 20 and 16 were placed in the superior group from most traits points of views. It had been an indicator of high potential of the genotypes from agronomy and morphological points of views. Therefore, considering the results of mean comparison of the traits, these genotypes can introduce as the superior genotypes. Garcia Del-Moral et al. (2003) also reported significant differences between genotypes for grain yield, number of grains per spike and grain weight. Also Ahmadizadeh et al. (2011b) studying genetic diversity of durum wheat landraces from Iran and Azerbaijan reported highly significant differences among the genotypes in all of the morphological traits. Molasadeghi and Shahryari, 2011 and Ahmadizadeh et al. (2011a) also reported similar results.

Factor analysis

Factor analysis is an effective statistical method in decreasing the volume of the data and getting the results of the data which showed high correlation among the primary variables (Cooper, 1983). Selecting factor numbers was done on the basis of root numbers larger than 1 and the number of the primary variables used in the factor analysis was equal to 9. This method was used effectively for identifying the relationships and structure of yield components and some traits of cultivated plants (Walton, 1971; Bramel et al., 1984). As seen in Table 2, with the total three factors, 87.55 % of the data changes were accounted. It should be mentioned that due to the more suitable formation of factor structures, factorial coefficients turned over through varimax method, and factorial coefficient was considered to be larger than 0.5, ignoring the related sign as significant coefficients (Tousi Mojarrad et al., 2005).

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The first factor that accounted for 41.43 % of the total variation had a positive correlation with plant height, infertile tiller, fertile tiller, straw yield and grain yield. Accordingly, the positive coefficients indicate that when this factor is introduced, it is effective in increasing the growth (Table 3). The second factor that accounted for 34.69 % of the total variations had a positive relationship with the number of grain spike, grain yield, grain weight 1000 and harvest index. Accordingly, the positive coefficients indicate that this is introduced as an effective factor in increasing the grain yield (Table 3). The third factor that accounted for 11.14 % of the total changes had a positive relationship with days to flowering and days to maturity. This factor can be named as a factor in phenological traits (Table 3). Finally, it is concluded that the second factor was introduced as the superior factor. They can have more usage in selecting genotypes for yield improvement. Peduncle length and plant height were mentioned as the fourth factor by Golparvar et al. (2002), as the fifth one by Mohammadi et al. (2002) and as the third factor by Damania and Jackson (1986). Xiao and Pei (1991) and Yildrim et al. (1993) mentioned the length of spike as the second factor. Walton (1971) used factor analysis to identify growth and morphological traits relevant to yield in spring wheat and introduced four factors which included yield components, morphological traits, spike length and the number of grain per plant, as well as the relationship between large grains and grain filling duration with high yield. Tousi Mojarrad et al. (2005) introduced five factors by complementing factor analysis with principal components analysis which accounted for 67.7% of the data variations as a whole.

CONCLUSION

Collection and characterization of various agronomic and phonological traits of genotypes are primary steps in plant breeding programs. The result showed that genotypes 14, 19, 10, 20 and 16 had high amount in terms of most traits. It had been an indicator of high potential of the genotypes from agronomy and morphological points of views. Therefore, considering the results of mean comparison of the traits, these genotypes can introduce as the superior genotypes. With respect to the results of factor analysis, the second factor could be introduced as an effective factor in increasing yield. It accounted for 34.69% of the total changes that this factor had a positive relationship with the number of grain spike, grain yield, grain weight 1000 and harvest index. Accordingly, the positive coefficients indicate that this is introduced as an effective factor in increasing the grain yield.

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Table 1. Mean values of studied traits, measured from 20 barley genotypes.

Genotype	Days to flowering	Plant height	1000 seed weight	Fertile tiller	No. seed spike	Harvest index	Days to maturity	Straw yield	Grain yield
1	b-e 131.7	95 c	30.83 j	3. 86 c-f	42.82 b-e	39.59 a-d	183 bc	4.10 bcd	6.49 bc
2	134 ab	92.83 ef	39.17 de	3. 70 e-h	37.82 d-g	37.79 d-g	183.7 ab	3.81 cde	5.65 b-e
3	132.7 a-d	93 ef	35.17 h	3.46 gh	41.10 b-f	38.64 b-g	183 bc	3.96 b-e	6.22 bcd
4	132 b-d	94.50 cd	35.33 h	4 b-e	45.03 abc	39.13 a-f	183 bc	4.26 bc	6.95 ab
5	130 efg	93 ef	40.33 cd	3.60 fgh	40.72 b-f	38.70 b-g	183.3 bc	3.92 b-e	6.18 bcd
6	132 b-e	93.50 def	44.50 ab	3.60 fgh	38.70 c-g	38.48 b-g	182.3 cde	3.93 b-e	5.95 b-e
7	128.7 gh	87 hi	36.50 gh	2.91 i	35.43 fgh	37.10 fg	183.7 ab	3.52 de	4.85 de
8	127 h	85 j	41.33 c	2.83 i	33.93 gh	36.91 g	178 f	3.43 e	4.62 e
9	131 d-g	93.32 def	33.17 i	4.27 ab	43.10 a-d	39.15 a-f	181.7 ef	4.09 bcd	6.52 bc
10	133.7 abc	93.83 c-f	35.67 h	4.12 a-d	45.60 ab	39.56 a-d	182.7 bcd	4.28 bc	6.97 ab
11	129 fgh	92.67 f	37.50 fg	3.37 h	39.85 b-g	38.25 c-g	183 bc	3.83 cde	5.89 b-e
12	132.7 a-d	94.83 c	37.33 fg	3.67 e-h	43.93 a-d	39.03 a-f	183 bc	4.10 bcd	6.72 ab
13	130.3 d-g	94 cde	41 c	3.77 d-g	42.67 b-e	38.60 b-g	181 f	4.11 bcd	6.27 bcd
14	130 efg	97.17 b	38.33 ef	4.27 ab	49.73 a	40.95 a	182 de	4.55 ab	8.01 a
15	129 fgh	102.8 a	45.83 a	4.44 a	29.63 h	32.37 h	183 bc	5.03 a	6.64 ab
16	131.3 c-f	93.83 c-f	33.67 i	4.03 b-e	44.77 abc	39.38 a-e	183.3 bc	4.22 bc	6.86 ab
17	131 d-g	86 ij	38.67 ef	3.44 gh	36.06 efg	37.33 efg	183 bc	3.66 cde	5.13 cde
18	130 efg	88 h	43.67 b	3.71 e-h	39.43 b-g	38.13 d-g	184.3 a	3.84 cde	5.76 b-e
19	132.3 a-e	90.83 g	40.50 cd	3.79 d-g	46.07 ab	40.36 abc	181.7 ef	4.06 b-e	7.10 ab
20	134.7 a	101.8 a	31.33 j	4.20 abc	45.67 ab	40.47 ab	182 de	4.24 bc	6.99 ab

Values with the same superscript letters are non-significantly different at $P < 0.05$.

Table 2. Factor analysis by principal components in 20 barley genotypes.

	Factor 1	Factor 2	Factor 3
Variance (%)	41.437	34.699	11.142
Cumulative (%)	41.437	76.136	87.556
Eigen values	4.144	3.470	1.142

Table 3. Factor analysis by principal components using varimax rotation in 20 barley genotypes.

Parameter	Factor		
	1	2	3
Days to flowering	0.341	0.593	0.465
Plant height	0.921	0.072	-0.015
1000 seed weight	-0.082	-0.934	0.107
Infertile tiller	0.843	0.052	0.251
Fertile tiller	0.914	0.218	-0.007
No. seed per spike	0.251	0.943	-0.101
Harvest index	-0.076	0.980	-0.065
Days to maturity	-0.052	-0.182	0.903
Straw yield	0.971	-0.036	-0.091
Grain yield	0.783	0.553	-0.114