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Selçuk Tarım ve Gıda Bilimleri Dergisi

Genotypic Variability for Seed Protein in Barley Germplasm

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ABSRACT

Barley accessions collected from South-West part of Central Anatolia, Turkey, were evaluated for seed protein for two seasons. A wide range of variation (6 to 19%) was found in the germplasm studied during both seasons. Maximum accessions exhibited 12.1-15% protein, whereas few accessions produced more than 16% protein. Correlation between two seasons' data (r=0.417**) was highly significant indicating the influence of environment component. Germplasm were classified on the basis of areas located, altitude and lemma colour in the region referred. Thus, accessions from Eastern areas possessed average higher protein percentage followed by accessions from Southern areas. Classification on the basis of altitude showed that the accessions collected from 900-1100 masl (meters above sea level) had lower protein while those collected from higher levels had higher protein. According to lemma colour, accessions with white lemma are more situated in the lower levels while those collected from higher levels had dark lemma. In this way, the study provides information on important protein sources of barley germplasm.

1. Introduction

For progress in plant breeding, variable genetic material is a prerequisite. The study was undertaken to evaluate genetic variability of barley germplasm based on seed protein and explore variation for future use in selection and breeding programs. Several researchers have studied protein contents of barley germplasm. He et al (1989) studied protein content of 6 barley types grown at 19 sites. Protein content was higher at sites in North China than at those in the South. Weltzein and Fischbeck (1990) reported that protein content were higher under favorable growing conditions. Similarly Atanassov et al (1999) evaluated different traits related to grain quality in 49 naked barley accessions. The effects of climatic factors on different components of quality were studied considering the variation across years. Accessions with high protein were identified for use in breeding programs. Sun and Wang (1999) studied a total of 6026 accessions of hulless barley germplasm for genetic diversity of protein. Fan et al (2002) reported eight barley cultivars that contained more than 12% protein. Ahmad and Yasmin (2010) evaluated the effects of region and altitude factors on seed protein contents in 133 barley germplasm considering the variation across years.

2. Material and Method

Eighty six hulled barley accessions were taken for this study. This collection comprised accessions from South-West part (36º41′-39º16′ N and 31º14′-34º26′ E) of Central Anatolia, Turkey, including areas of Konya, Isparta and Karaman provinces (Table 1). Three commercial barley cultivars viz. Tarm 92, Karatay 94 and Tokak 157/37 were also used as checks.

Accessions were planted for two consecutive seasons (2008-2009 and 2009-2010) in an augmented design under dry fed conditions. The annual average of the total precipitation is 320 L/m^2 in a year most falling between October and June with peaks in December and May (Figure 1).

The temperature ranges from 27.6°C to 0.5°C (Figure 2) with the soil type classified as Clay loam with a pH of 8.00.

The seeds harvested were taken for protein contents. Protein content of the grain was determined by Dumas' method (Anonymous, 2000) with a LECO TruSpec CN protein analyzer.

The data recorded were averaged and analyzed for mean, range, variance, standard error and correlation coefficient. The data were also analyzed on the basis of lemma colour, areas and altitude of the region referred.

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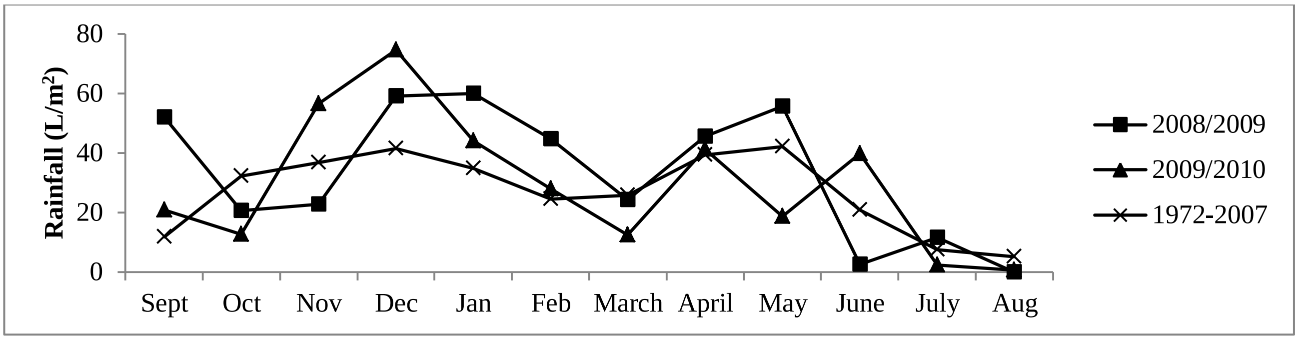

Figure 1
Monthly rainfall data of the experimental field

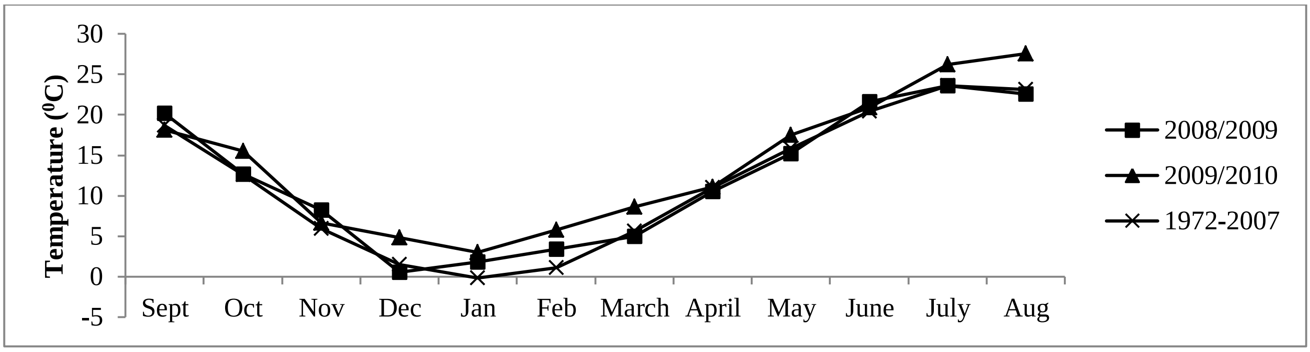

Figure 2
Monthly temperature data of the experimental field

3. Results and Discussion

The data during 2009 ranged from 6.53-19.81% with mean value of 11.56 % and variance 4.97. Maximum accessions (38) exhibited protein 12.1-15.0% whereas few accessions produced more than 16.0 percent protein. During 2010 seed protein ranged from 7.57-14.84% with mean value of 10.97% and had variance 2.54 (Table 2). The different climate conditions of the years, mainly their different amounts of precipitations in May and June, were the causes for distinctions in the protein indices of the years (Figure 1 and 2). In this way, correlation between two seasons' data (r=0.417**) was highly significant indicating the influence of environment component.

These landraces represented a valuable genetic resource that could be used to develop new barley cultivars with improved end use quality traits. Dong et al (2003) and Ahmad and Yasmin (2010), evaluating barley accessions for quality characteristics, indicated that the quality trait indices of all tested accessions possessed significant variation.

Table 1
Passport data of barley accessions/landraces collected from South-West part of Central Anatolia, Turkey

Succession No	Location	Accession No	Altitude (masl)*	Areas**	Lemma colour
1	Konya/Tuz gölü	T744	911	Northern	white
2	Konya/Tuz gölü	T748	911	Northern	grey
3	Konya/Tuz gölü	T749	911	Northern	white
4	Konya/Gölyazı	T745	916	Northern	white
5	Konya/Gölyazı	T752	916	Northern	white
6	Konya/Akşehir	T76	970	Western	grey
7	Konya/Akşehir	T736	970	Western	white
8	Konya/Akşehir	T736	970	Western	black
9	Konya/Akşehir	T787	970	Western	white
10	Konya/Akşehir	T787	970	Western	white
11	Konya/Karapınar	T750	1004	Eastern	white
12	Karaman	T722	1025	Southern	white
13	Karaman	T731	1025	Southern	white
14	Konya/Altınekin	T733	1050	Northern	white
15	Konya/Altınekin	T733	1050	Northern	white
16	Konya/Altınekin	T734	1050	Northern	white
17	Konya/Altınekin	T767	1050	Northern	white
18	Konya/Altınekin	T771	1050	Northern	white
19	Konya/Altınekin	T780	1050	Northern	white
20	Konya/Altınekin	T783	1050	Northern	white
21	Konya/Altınekin	T753	1050	Northern	white
22	Konya/Altınekin	T753	1050	Northern	white
23	Konya/Çumra	T741	1051	Southern	white
24	Konya/Sarayönü	T77	1078	Northern	white
25	Konya/Sarayönü	T755	1078	Northern	grey
26	Konya/Sarayönü	T757	1078	Northern	black
27	Konya/Sarayönü	T760	1078	Northern	black
28	Konya/Sarayönü	T761	1078	Northern	grey
29	Konya/Sarayönü	T763	1078	Northern	white
30	Konya/Sarayönü	T766	1078	Northern	black
31	Konya/Sarayönü	T768	1078	Northern	black
32	Konya/Sarayönü	T768	1078	Northern	white
33	Konya/Sarayönü	T769	1078	Northern	white
34	Konya/Sarayönü	T769	1078	Northern	black
35	Konya/Sarayönü	T781	1078	Northern	black
36	Konya/Sarayönü	T781	1078	Northern	black
37	Konya/Sarayönü	T782	1078	Northern	black
38	Konya/Sarayönü	T792	1078	Northern	black
39	Konya/Dinar	T758	1110	Southern	black
40	Konya/Altınekin	T737	1113	Eastern	black
41	Konya/Altınekin	T737	1113	Eastern	black
42	Konya/Altınekin	T754	1113	Eastern	black
43	Konya/Altınekin	T754	1113	Eastern	black
44	Konya/Seydşehir	T710	1121	Western	grey
45	Konya/Seydşehir	T785	1121	Western	black
46	Konya/Seydşehir	T788	1121	Western	black
47	Isparta/Şakikaraağaç	T75	1143	Western	grey
48	Isparta/Şakikaraağaç	T711	1143	Western	black
49	Isparta/Şakikaraağaç	T740	1143	Western	grey
50	Isparta/Şakikaraağaç	T742	1143	Western	grey
51	Isparta/Şakikaraağaç	T742	1143	Western	black
52	Isparta/Şakikaraağaç	T773	1143	Western	black
53	Isparta/Şakikaraağaç	T784	1143	Western	black
54	Isparta/Şakikaraağaç	T784	1143	Western	black
55	Konya/Beyşehir	T762	1161	Western	black
56	Konya/Beyşehir	T794	1161	Western	white
57	Konya/Beyşehir	T717	1161	Western	white
58	Konya/Güneysınır	T730	1167	Southern	white
59	Isparta/Yalvaç	T759	1167	Western	black

Table 1(Continuation)

Passport data of barley accessions/landraces collected from South-West part of Central Anatolia, Turkey

60	Isparta/Yalvaç	T759	1167	Western	black
61	Isparta/Yalvaç	T786	1167	Western	black
62	Isparta/Yalvaç	T789	1167	Western	black
63	Isparta	TR54639	1182	Western	grey
64	Isparta	TR54645	1182	Western	black
65	Konya/Doğanhisar	T714	1200	Western	white
66	Konya/Doğanhisar	T732	1200	Western	white
67	Konya/Akyokuş	T756	1305	Western	black
68	Konya/Seydşehir	T712	1348	Western	black
69	Konya/Seydşehir	T765	1348	Western	black
70	Isparta/Şakikaraağaç	T740	1349	Western	grey
71	Isparta/Şakikaraağaç	T790	1349	Western	grey
72	Isparta/Eğirdir	T791	1380	Western	black
73	Konya/Sarayönü	T792	1398	Northern	grey
74	Konya/Sarayönü	T71	1398	Northern	black
75	Konya/Sarayönü	T74	1398	Northern	black
76	Konya/Sarayönü	T720	1398	Northern	grey
77	Konya/Sarayönü	T738	1398	Northern	grey
78	Konya/Sarayönü	T764	1398	Northern	grey
79	Konya/Sarayönü	T769	1398	Northern	grey
80	Konya/Sarayönü	T774	1398	Northern	black
81	Konya/Kızören	T777	1413	Western	black
82	Konya/Deşttiğin	T719	1500	Western	grey
83	Konya/Çumra	T713	1500	Southern	grey
84	Konya/Çumra	T728	1500	Southern	grey
85	Karaman	T723	1500	Southern	grey
86	Karaman	T724	1500	Southern	grey

*: Meters above sea level, **: Areas of the region referred

During both years, high level of genetic variation (19.29% and 14.49%, respectively) for protein contents could be used efficiently for design a new plant variety according to the need of different regions of the country (Table 2). Sun et al (1999) studied a total of 6026 accessions of hull less barley germplasm for genetic diversity of spike morphology, some agro economic traits along with protein content and their geographical distribution. They suggested the utilization of potential of advanced germplasm. Similarly, Ahmad and Yasmin (2010) evaluated the effects of region and altitude factors on seed protein contents in 133 barley germplasm considering the variation across years.

Table 2

Statistics of barley accessions for protein contents (%)

Year	**Mean ± S.E*.**	**Range**	**Variance**	**CV (%)****
2008-2009	11.56 ± 0.24	6.53-19.81	4.97	**19.29**
2009-2010	10.97 ± 0.17	7.57-14.84	2.54	**14.49**

*: Standard error; **: Coefficient of variation.

Areas-wise average protein percentages for two years is exhibited in Table 3, where higher protein percentage was observed in accessions from Eastern areas followed by Southern areas, because the prevailing number of these accessions were with dark lemma and sited at 1100-1500 meters above sea level. While the prevailing number of Northern and Western accessions were with lighter lemma and sited at 900-1200 meters above sea level (Table 1). Similarly, Northern and Western accessions had higher standard deviation, respectively higher variation, probably because of the known presence in the all altitudes referred.

Table 3
Areas-wise statistics of barley accessions for protein contents (%)

Year	Northern areas[a] (36)[b]	Western areas (35)	Eastern areas (6)	Southern areas (9)	Checks
2009	6 – 19* 11.28 ± 2.71**	8 – 15 11.48 ± 1.93	11-14 12.51 ± 1.52	10- 14 12.34 ± 1.18	10 - 13 11.87 ± 1.52
2010	7 - 15 11.00 ± 1.95	9 – 14 10.84 ± 1.22	9-13 11.42 ± 1.71	9 - 14 11.07 ± 1.37	10 - 13 11.62 ± 1.10

a: Areas of the region referred, b: Number of accessions, *: Ranges, **: Mean ± Standard deviation

This proposes that accessions from a particular region and with dark lemma should be utilized to develop barley cultivars possessing higher protein percentage and better adaptability by exploiting the regional germplasm. Also Gilani and Witcombe (1980) exposed the distribution of morphological variability of primitive barley from Northern Pakistan and reported that Pakistani hulless barley showed different regional variation.

Differentiation of accessions according to geographical regions on the basis of agro morphological and biochemical traits is essential not only for its utilization but also to understand the possible regions of diversity (Vavilov 1951). It has been reported that the accessions from diverse geographical areas of a crop species help to ensure conservation of co-adapted gene complexes (Ahmad and Yasmin 2010, Kızılgeçit et al 2016, Oral et al 2017).

On the basis of altitude, it was seen that the accessions collected from 900-1100 masl showed lower protein. The germplasm collected from 1301-1500 masl had higher protein (Table 4).

The material under investigation gave also high variation for protein content for most of the collection sites on the basis of lemma colour (Tables 5 and 6). Barley accessions with white lemma are more situated in the lower levels while those collected from higher levels had dark lemma. As well, accessions with white lemma had lower protein than those with dark lemma.

Table 4
Altitude-wise statistics of barley accessions for protein contents (%)

Year	900-1100[a] (38)[b]	1101-1300 (28)	1301-1500 (20)
2009	6 – 14* 10.63 ± 1.92**	7 - 15 11.44 ± 2.00	9 - 19 13.50 ± 1.91
2010	7 – 13 10.36 ± 1.35	8 - 15 10.96 ± 1.58	9 - 15 12.14 ± 1.44

a: Meters above sea level, b: Number of accessions, *: Ranges, **: Mean ± Standard deviation

Table 5
Lemma colour-wise statistics of barley accessions for protein contents (%)

Year	White (28) [a]	Grey (21)	Black (37)
2009	6 – 14* 11.25 ±2.16**	7 - 15 11.28 ± 2.45	8 - 19 11.94 ± 2.22
2010	7 – 14 10.78 ± 1.48	8 - 15 10.82 ± 1.22	9 - 15 11.19 ± 1.79

*: Min-Max, **: Mean ± Standard deviation, a: Number of accessions

Correlations of protein content with areas, altitude and lemma colour during two crop seasons were positively significant (Figure 3a, 3b and 3c). While results for relationships between lemma colour and altitude showed that after 1300 masl is impossible to meet barley accessions with white lemma (Figure 3d). On the basis of selected parents from these identified groups may produce desirable recombinants for further breeding programs (Ahmad and Yasmin 2010). Ruiz et al (1997) studied the relationship between geographical, agro-morphological and biochemical parameters in barley landraces. They reported that agro-morphological characters like days to heading, maturity and plant height had the highest correlation with the geographical parameters. Association of protein and altitude was also calculated.

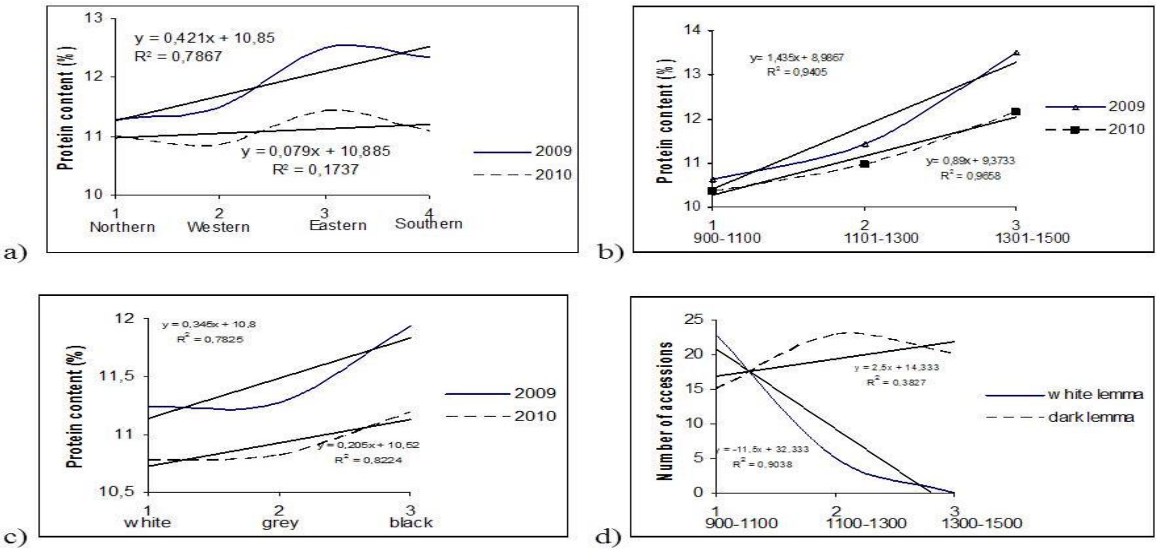

Figure 3

Relationships between protein content and areas (a), altitude (b) and lemma colour (c), lemma colour and altitude (d) of barley accessions

4. Conclusion

This result demonstrates that in the South-West part of Central Anatolia exists high variability for protein content on the basis of areas, altitude and lemma colour. Despite significant pressure of the environment, high variability for protein content in this study helps to identify sites and regions with potentially interesting material for breeding or growing and to allow the efficient utilization of such material in breeding programs. The study revealed also that studies must be made in several locations of the region referred. This could be the nature of landraces because of their better adaptive traits to variable environmental conditions which have important implications for sustainable crop production.

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