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I. Introduction

Wheat is the cultivated crop in the world. With the purpose of meet the increasing demand of food in tremendously increasing human population, aim in breeding programs is to develop high yielding cultivars possessing high quality, resistant to cold, drought and heat stress (Blum, 1988; Wilson, 1984). Success to overcome these troubles is not sufficient, sustainability in these properties of is also important, a number of studies have been made to increase for this purpose (Metakovsky and Branlard, 1998). Success in breeding programs is closely related to opulence in number of breeding materials affecting released cultivars. Reductions in the number of germplasm materials by using limited number of parents in breeding programs and diminish variation in new characters. Besides, keeping genetic purity in cultivars, in other words sustaining production pure seed production will create opportunity to address different market's demands, consequently, classification certain physiological, physiological and quality traits vital (Akcura, 2006). Certain traits have been used to classify wheat genotypes such as physiological and quality traits and gliadin subunits (Weegels et al., 1996; Metakovsky et al., 1997; Metakovsky and Branlard, 1998; Ojaghi and Akhundova, 2010). Combinations for each trait create opportunity to distinguish genotypes each other (Ojaghi and Akhundova, 2010). Orth et al. (1996) stressed that many of physical and chemical tests could make the assessment of wheat genotypes for quality and these measurements strongly depend upon physical and chemical composition of wheat seed. Once physiological, physiological and quality traits are under genotype x environment interactions and a trait could be showed variations in different year or locations (Nevo et al., 1988). But gliadin sequence for each genotype is not affected by environment to identify genotypes (Zillman and Bushuk, 1979). Gliadins are the important seed proteins, evaluating and identifing genetic differences of genotypes could be safely made by them (Bushuk and Zillman 1978; Nevo and Payne 1987; Pfluger et al.2001). Reductions in the number of germplasm materials by using limited number of parents in breeding programs and diminish variation in new characters (Porceddu et al., 1988). Even tough morphometric characters (yield, yield components ect.) have been intensively used studies related to genetically diversity headed for protein bands such as gliadins (Metakovsky and Branlard, 1988). Gliadin (dissolved in etile alcohol, 70%) important part of wheat protein having high level of proline its named as prolamine (Zillman and Bushuk 1979). Gliadins as monomeric proteins could be classified to ω, γ, β, α groups (Jones et al.,1959). Most gliadin genes placed at first (Gli-1) and sixth (Gli-2) homology groups (Payne, 1987) and Gli-4 and Gli-5 groups in short arm of D chromosome (Rodrigve and Carrillo, 1996). Quality and agronomic traits have been commonly used in breeding programs, but determining quality and agronomic traits in genotypes needs long-term measurements to reach reliable results, since they are widely affected from environmental conditions (Metakovsky and Branlard, 1998; Ojaghi and Akhundova, 2010). Gliadin pattern of wheat genotypes are free from environment, they are easy and forceful method in evaluation of genetic materials, breeding programs, pure seed productions in hexaploid wheat.

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The aim of this study was to reveal genetic diversity by examining agronomic and quality traits, and gliadin patterns in bread wheat.

II. Materials and Methods

Study was conducted in experimental station Osmangazi University Agricultural Faculty during 2009-2010 seasons. Long-term annual precipitation in Eskişehir province is 411.1 mm. Precipitation was 286.9 mm in 2009-2010 and 384.0 mm in 2010-2011 growing seasons. The soil had loamy-clay texture; 2.85 dS/m electrical conductivity, 7.21 pH (H_2O), 0.38% $CaCO_3$, 42,24 kg P_2O_5/ha available phosphorus, 3342 kg K_2O ha^{-1} and 1.70% organic matter. In the study, ammonium sulphate (21%N) and triple super phosphate (46%) were used as fertilizers. Experimental design was randomised completed block design with three replication. Plot size was 6 m x 1.2 m (7.2m^2). Seed were sown in 15 October and seed rate was 500 seed/m^2. 60 kg N/ ha (½ at sowing stage and ½ at tillering stage) and 60 kg P_2O_5/ha (at sowing) were applied. Wheat was sown in 1-15 September at the rate of 475 seed/m^2. Plot size was 6 m x 1.2 m (7.2m^2) at sowing. No K fertilization was made. Plots received (2000 cc/ha) applications of 2,4-D ester [(2,4-dichlorophenoxy)acetic acid] in early spring to control winter annual broadleaf weeds. Plot size at harvest for determining grain yield was 0.80 m x 5 m (5.0 m^2). Plots were harvested in 15th of July in 2009-2010 and 14th of July in 2010-2011. Bread wheat genotypes are Prostor, Eser, Daphan, Kınacı 97, Bağcı 2002, Tosunbey, Karahan 99, Katea 1, Nenehatun, Lancer, Karasu 90, Alparslan, Palandöken 97, Konya 2002 and Doğu 88 were used. Pedigree of wheat genotypes are given in Table 1. Agronomic characters; seed yield and plant height, seed number/spike, seed weight/spike, spikelet number, harvest index and 1000 grain weight (Slafer and Miralles, 1992) were evaluated. Quality characters; protein and gluten contents (Poehlman, 1987), zeleny sedimentation (Zeleny, 1947), farinograph, water absorbtion (Lehmensiek et al., 2006), alveograph, W_{energy} (Bettge et al., 1989), test weight (Sade et al., 1999), 1000 seed weight (Uluöz 1965) and PSI (Hruskova and Svec, 2009) were evaluated. Cluster analyses were made by MINITAB 16 Pocket Program. For gliadin subunits, sodium dodecylsulfate polyacrylamide gel electrophoresis (SDS-PAGE) analysis was used. Gliadin proteins were performed on vertical slab (Rashed et al., 2007). Relative mobility measures were used to evaluate gliadin band models. Relative motilities of bands were measured by formula (Keskin et al., 1996).

Rm=distance of bands measured from origin/ distance of reference band from origin x 45,5.

Table 1 : Pedigree of wheat genotypes

GENOTYPE	PEDIGRREE	Releas. Year
Prostor	Russalka imp./Nadadores63	1999
Eser	AGRI/NAC//LIRA	2003
Daphan	JUP/4/CLLF/3/II4.53/ODIN//CI14431/WA00477	2002
Kınacı 97	YAMHILL/TOBARI-66//MCDERMID/3/LIRA	1997
Bağcı 2002	HN7/OROFEN//BJN8/3/SERI82/4/74CB462/TAPPER/VONA	2002
Tosunbey	EÇVD-12/KRÇ-66//CROW"S"	2004
Karahan 99	C-126-15/COLLAFEN/3/NORIN-10-BREVOR/P-14//PULLMAN-101/4/KIRAÇ-66	1999
Kate a 1	Hebros/Bez-1	1998
Nenehatun	ND//P101/BLUEBOY SWM584	2001
Lancer	TK/CNO//NE-451406	1977
Karasu 90	LOM11/B12973//MİR264	1990
Alparslan	TX69A509-2//BBY2/FOX	2001
Palandöken 97	AU//YT54*2/N10B/3/II8260/5/PNC/CM//NB6977/3/CC/INIA//BB/4/MXP//KR/FUNO	1997
Konya 2002	KANRED/TENMARG//P211-6/3/2183/CO652643/LANCER	2002
Doğu 88	Bez/Dane//CO725052	1990

III. Results and Discussion

Genotypic/phenotypic diversity or classification in bread wheat genotypes are successfully made by using physiological, quality traits and gliadin subunits (Clarke et al., 1991; Yang et al., 1991; Metaovsky et al., 1990; Vaquero et al., 1990). Although physiological and quality traits are substantially connected to the environmental conditions, gliadin subunits are not affected by environmental conditions (Zillman and Bushluk, 1979; Metakovsky and Branlard, 1998). Maximum, minimum values and means in agronomic and quality traits and relative mobility of gliadin subunits, are given Table 2. Introduction and selection are milestones in wheat breeding. To obtain information about genotypes are commonly revealing characteristics of genotypes by agronomic and quality and electrophoresis methods including protein analysis

(Soizow and Poperelya, 1980; Metakovsky and Branlard, 1998). Once gliadin structure remains unchanged through generations, agronomic and quality traits are under genotype x environment interactions, and electrophoresis is therefore safe method to describe protein characteristics of genotypes (Bushuk and Zillman, 1978; Metakovsky and Branlard, 1998). Table 1 sows that relative mobility of gliadin subunits were varied from 20,33 to 76,47 (20,33-25,29 in ω, 44,33-49,49,08 in γ, 54,33-62,35 in β and 71,00-76,47 in α). Depending upon increasing mobility, gliadin protein fractions are grouped in four main groups ω, γ, β, α gliadin subunits (Bietz and Wall, 1973; Kharebian et al., 2008). Gepts (1990) stressed that genotypes can be successfully grouped or evaluated according to relative mobility of different gliadin groups.

Researchers stated that gliadin structures (Nevo and Payne, 1987; Bushuk and Zillman, 1978), agronomic and quality traits of genotypes are differed (Lee and Ronalds, 1967; Wrigley, 1970). Whole three traits could safely be used in genotype classification (Metakovsky and Branlard, 1998; Ojaghi and Akhundova, 2010), but the safest method is gliadin electrophoresis method (Zillman and Bushuk, 1979). A number of researches demonstrated the relationship of gliadin polymorphism with genetic diversity (Nevo and Payne, 1987). In our study each gliadin band fractions are evaluated in subgroups, ω, γ, β and α and are shown in Figure 1.

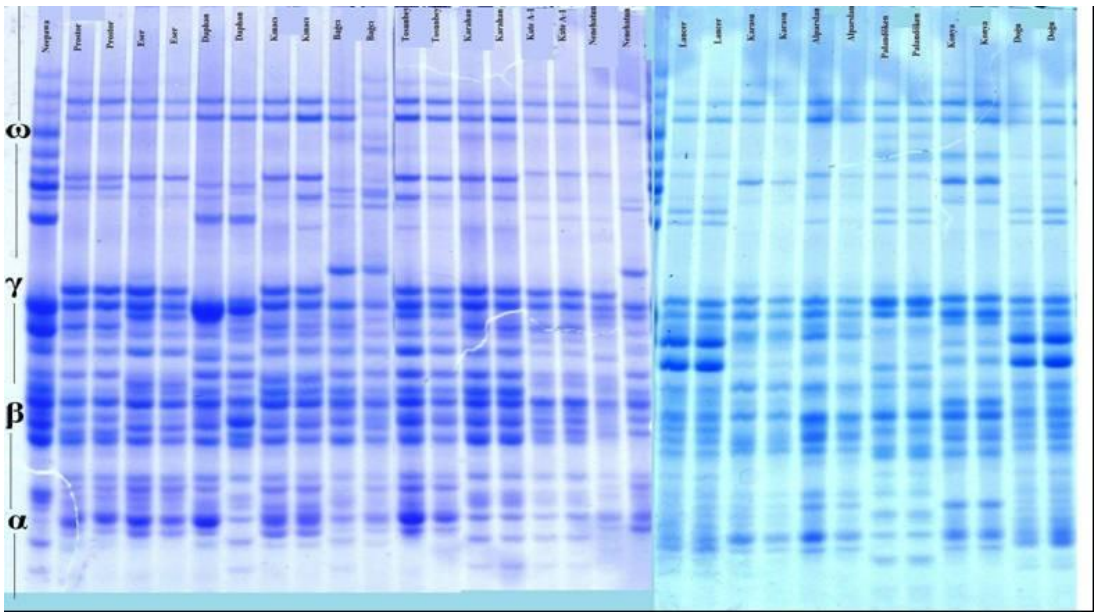

Figure 1 : Gliadin band subunits, ω, γ, β and α in bread wheat genotypes

Table 2 : Maximum, minimum values and means in agronomic and quality traits and relative mobility of gliadin subunits in bread wheat genotypes

Traits	Minimum	Maximum	Mean
Rm of Gliadin subunits			
ω	20,33	25,29	22,87±1,60
γ	44,33	49,08	46,19±1,96
β	54,33	62,35	63,38±1,40
α	71,00	76,47	73,45±1,59
Agronomic Traits			
Plant Height	85,40	142,47	109,12±14,83
Spike Heigh	7,73	11,35	9,61±1,02
Spikelet Number	14,40	18,67	16,38±1,27
Seed Number per Spike	28,47	57,87	38,92±8,36
Seed Weight per Spike	1,23	2,23	1,73±0,30
Harvest Index	42,34	56,67	25,08±7,21
Grain Yield	218,11	582,67	362,30±100,13

Quality Traits			
PSI	54,34	75,33	67,99±6,31
Thousand Seed Weight	38,02	55,04	44,94±5,38
Test Weight	72,49	79,28	76,88±1,65
Protein Content	10,81	13,36	12,17±0,62
Zeleny Sedimentation	27,66	43,80	35,23±4,96
Alveograph W_{Energy}	96,01	263,42	161,72±44,25
Farihograph Water Absorbtion	53,40	62,70	57,37±2,63
Gluten Content	23,00	38,00	28,00±3,87

We found notable polymorphisms among bread wheat genotypes on ω, γ, β and α gliadin subunits where γ and β have the heaviest molecular weights in Figure 1. Spectrum and density of molecular changed among ω, γ, β and α gliadin subunits in genotypes (Bietz and Wall, 1973; Nevo and Payne, 1987; Keskin et al.,1999). Kharabian et al. (2008) focused that ω has heaviest molecular weights. In our study, heavier molecular weights on γ, β gliadin subunits in Eser, Daphan, Kınacı 97, Tosunbey and Karahan 99 were found than that of the other genotypes. Moreover, differences in gliadin subunits assign differences of wheat genotypes, and ω, γ, β and α gliadin subunits are mostly located in Gli-A_1 and Gli-B_1 locus (Lafiandra and Kasarda, 1985; Kharabian et al., 2008), new giladin genes in Gli-D_4 Gli-D_5 (Rodriquez and Carrillo, 1996). Rashed et al. (2007) focused that ω region were so rich in the number of bands. The dendogram tree showed the similarity index of wheat cultivars detected by Rm of gliadin pattern (Figure 2).

The dendogram divided wheat genotypes in seven clusters. Prostor, Konya 2002, Palandöken 97 and Karasu 90 placed in separate groups. Once Eser, Tosunbey, Karahan 99, Kınacı 97 and Daphan genotypes placed one group; Lancer, Alparslan, Doğu88 and Bağcı 2002 another group. Nevertheless, Katea 1 and Nenehatun genotypes showed similar characteristics and placed same group (Figure 2). Gepts (1990) stressed that genotypes can be successfully grouped or evaluated according to relative mobility of different gliadin groups. According to Tanaka et al. (2003) wheat genotypes in Japan mainly different from other countries for gliadin pattern. Being main protein fragment in storage proteins, gliadins are important for bread making quality in hexaploid wheats (Kasarda et al., 1984). Nizar (2002) stated that determining gliadin pattern of wheat genotypes is safe method to classify cultivars and he successfully classified *T. durum* cultivars. Until recently, morphometric characters had been used in genetic diversities of wheat genotypes. Now, electrophoresis based techniques have been used for the determination and description of genotypes in cereals (Persson and Von Bothmer, 2000).

Genotypes segregate their own gliadin fraction; band pattern are characteristic of the genotype and aren't affected from environmental conditions (Bushuk and Zillman, 1978). Gliadin proteins having ω, γ, β, α gliadin subunits with combination of glutenins are play important role agronomic and bread making traits (Ojaghiand and Akhundova, 2010).

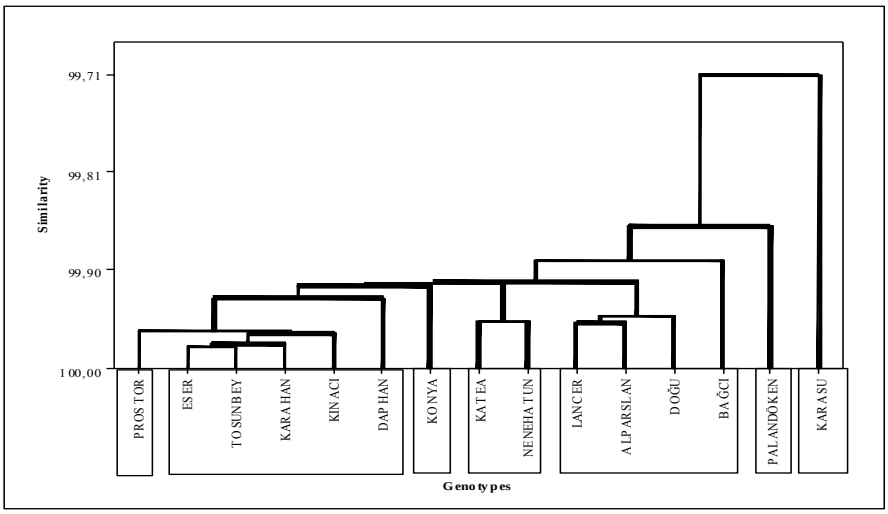

Figure 2 : Dendogram assigning genetic relationships among bread wheat genotypes for gliadin pattens

Agronomic characters are essential corner stones of breeding programs (Darwinkel et al., 1977; Genc, 1977; Poehlman, 1987). A number of yield components are used not only in breeding programs but genotype description. Monitoring such yield and yield components separately or their relationships each other lights the way for breeding programs, agronomic studies and genotype classification (Hsu and Walton, 1971; Nass, 1973; McVetty and Evans, 1980). Plant and spike heights, spikelet and seed numbers per spike, seed weight per spike, harvest index and grain yield are some of the most used characters and they could be used in genotypic classification (Ojaghi and Akhundova, 2010). Similar to gliadin patterns, agronomic traits ranged 85,40-142, 47 cm in plant height, 7,73-11,35 cm in spike height, 14,40-18,67 in spikelet number per spike, 28,47-57,87 in seed number per spike, 1,23-2,23 gr in seed weight per spike, 42,34-56,6 in harvest index and 218,11-582,67 kg/da in grain yield (Table 2). Agronomic characters are commonly are named as yield components. The dendogram tree of agronomic traits is given in Figure 3.

Evaluated in eight were wheat genotypes (Figure 3). Prostor, Konya 2002 and Katea 1 drew their own single groups. The other wheat genotypes formed dual or multiple groups: dual groups; Nenehatun and Doğu 88, Karasu 90 and Karahan 99, Alparslan and Lancer wheat genotypes; multiple group; Eser, Tosunbey, Daphan, Bağcı 2002 and Kınacı 97 wheat genotypes. Even though agronomic traits are under genotype x environment interactions, with certain approaches they are used to show genotypic differences (Metakovsky and Branlard, 1998; Ojaghi and Akhundova, 2010). Similar to our findings, Nenehatun, Doğu 88, Alparslan and Karasu 90 have similar yield capacity and they are suggested to Eastern Anatolia climatic conditions. In the same way, Tosunbey, Eser, Kınacı 97 and Bağcı 2002 were developed for Central Anatolia climatic conditions.

The aim of bread wheat breeding programs is to develop high yielding and high-quality wheat cultivars. To achieve this aim, in addition of yield potential, wheat genotypes are evaluated for high quality such as for protein content, zeleny sedimentation, energy value such as alveograph W_{energy}, water absorption and test weight (Dexter et al. 1981; Atlı 1999; Akcacık, 2006). Genotypes having higher values in protein content, zeleny sedimentation, alveograph W_{energy}, farinograph water absorption and test weight will be promising genotypes in breeding programs (Arat, 1949., Seçkin, 1970., Ünal, 1991., Atlı, 1999). The dendogram tree of quality traits is given in Figure 4.

Genotypes could be divided into nine groups (Figure 4). Prostor, Daphan, Konya 2002, Bağcı 2002 and Eseer wheat genotypes had single groups. Nenehatun, Palandöken 97 The other wheat genotypes formed dual or multiple groups: dual groups; and Doğu 88, Karasu 90 and Karahan 99, Alparslan and Lancer wheat genotypes; multiple group; Eser, Tosunbey, Daphan, Bağcı 2002 and Kınacı 97 wheat genotypes. Even though agronomic traits are under genotype x environment interactions, with certain approaches they are used to show genotypic differences (Metakovsky and Branlard, 1998; Ojaghi and Akhundova, 2010). Similar to our findings, Nenehatun, Doğu 88, Alparslan and Karasu 90 have similar yield capacity and they are suggested to Eastern Anatolia climatic conditions. In the same way Tosunbey, Eser, Kınacı 97 and Bağcı 2002 were developed for Central Anatolia climatic conditions.

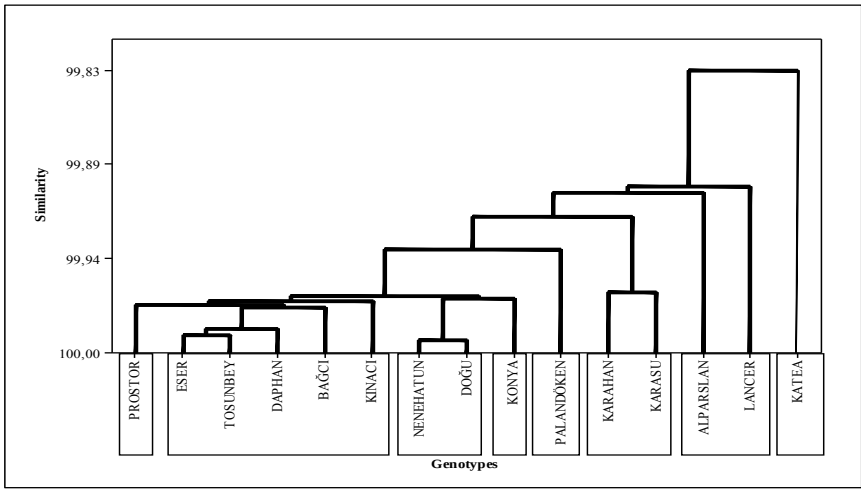

Figure 3 : Dendogram of agronomic traits showing relationships among bread wheat genotypes

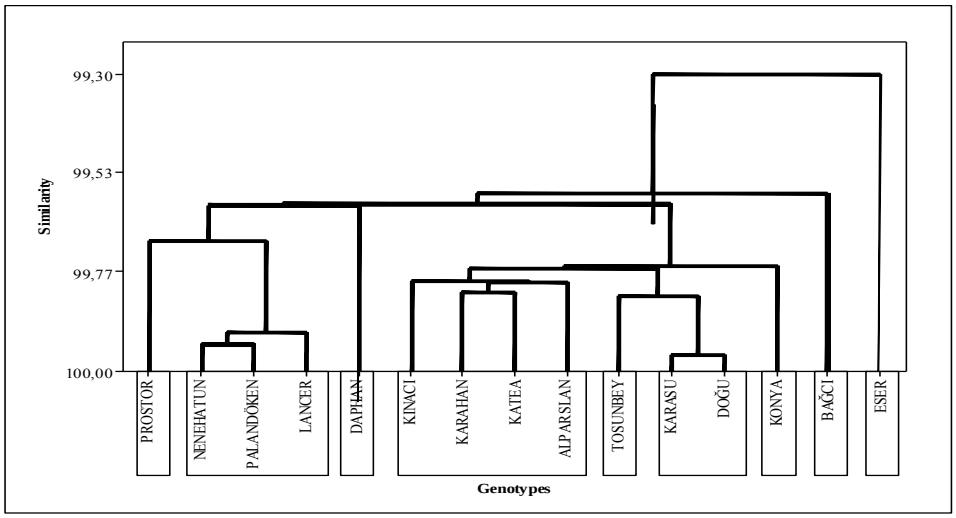

Figure 4 : Dendogram of quality traits showing relationships among bread wheat genotypes

Table 3 shows joint analysis of wheat genotypes for gliadin subunits, agronomic and quality traits. Prostor wheat genotype differed fro the other genoypes in three traits (gliadin subunits, agronomic and quality traits); Eser, Tosunbey and Kınacı 97 genotypes showed similarities in agronomic traits and gliadin subunits. As described earlier, some genotypes presented similarities in each analysis and these similarities in terms of genotypes was different for each traits (gliadin subunits, agronomic and quality traits).

Interesting phenomenon is that some genotypes could exhibit similarities by some traits (Eser, Tosunbey and Kınacı 97 genotypes in agronomic traits and gliadin subunits).or a genotype could significantly differ in all traits (Prostor genotype in all three traits). Studies revealed that agronomic and quality traits in wheat genotypes subject to genotype x environment interactions and this interaction differs in each genotype (Rodrigve and Carrillo, 1996; Şehirali and Özgen, 2007). Gliadin subunits stable with genotypes and don't change with changing environmental conditions (Bushuk and Zillman 1978; Rodrigve and Carrillo, 1996; Persson and Von Bothmer, 2000). Genetic diversity in genotypes can be controlled by polymeric markers and electropheretic patterns of gliadin subunits in genotypes are therefore very useful not only in genotype identification but in breeding programs (Nevo and Payne 1987; Metakovsky and Branlard, 1998; Pfluger et al., 2001). Studies stressed that agronomic and quality traits can be used in genotype classification (Kün, 1985; Şehirali, 2007), but both are influenced from genotype and environment conditions (Darwinkel et al., 1977; Genc, 1977; Poehlman, 1987; Gupta et al., 1993; Indrani and Venkateswara, 2000). Correlations between gliadin subunits, agronomic and quality traits are shown in Table 4. Positive and significant correlation ($P<0,05$) was found between protein content and α gliadin pattern. Besides correlations between seed number per spike and ω gliadin pattern, seed number per spike and α gliadin pattern, seed number per spike and β gliadin pattern, seed weight per spike and ω gliadin pattern, spikelet number per spike and test weight, spikelet number per spike and thousand seed weight were determined as negative and significant ($P<0,05$). Moreover, correlations between seed number per spike and γ gliadin pattern, seed number per spike and β gliadin pattern, seed weight per spike and ω, γ, β, α gliadin patterns, spike height and test weight were negative and significant at 1% (Table 4).

Table 3 : Joint analysis of wheat genotypes for gliadin subunits, agronomic and quality traits

Quality Traits	Prostor	Nenehatun	Palandöken 97	Lancer	Daphan	Kınacı 97	Karahan 99	Katea 1	Alparslan	Tosunbey	Karasu 90	Doğu 88	Konya 2002	Bağcı 2002	Eser
Gliadin Subunits	Prostor	Eser	Tosunbey	Karahan 99	Kınacı 97	Daphan	Konya 2002	Katea 1	Nenehatun	Lancer	Alparslan	Doğu 88	Bağcı 2002	Palandöken 97	Karasu 90
Agron. Traits	Prostor	Eser	Tosunbey	Bağcı 2002	Kınacı 97	Daphan	Nenehatun	Doğu 88	Konya 2002	Palandöken 97	Karahan 99	Karasu 90	Alparslan	Lancer	Katea 1

Table 4 : Correlations between gliadin subunits, agronomic and quality traits

	ω	γ	β	α		PSI	TeWe	ThSW	WAb
PSI	0,119	-0,010	0,185	0,308	Plant Height	-0,192	-0,194	0,154	0,297
Test Weight	0,104	0,210	-0,205	0,031	Spike Height	0,009	-0,689**	-0,246	-0,464
Thou. Seed We.	-0,049	-0,008	0,038	-0,320	Splt per Spk.	-0,071	-0,552*	-0,685*	-0,250
Protein Con	0,201	0,409	0,329	0,635*	Seed per Spk	-0,057	-0,553*	-0,177	-0,426
Zeleny Sedim.	0,128	0,178	-0,115	0,281	Seed W.per Spk	-0,093	-0,465	0,091	-0,347
Alveo. W_{en}	-0,061	0,237	-0,156	0,243	Harvest Index	-0,093	-0,189	0,392	-0,020
Farin. Water Ab	0,036	0,404	0,048	0,221	Yield	0,170	-0,219	0,439	-0,015
Gluten Index	-0,052	-0,035	-0,092	-0,105		PrCo	Sed	Wen	GI
Plant Height	-0,025	0,357	0,497	0,265	Plant Height	0,010	0,061	-0,078	0,086
Spike Height	-0,239	-0,367	0,155	-0,069	Spike Height	-0,279	-0,195	-0,410	0,198
Splt per Spk.	-0,105	-0,240	-0,163	0,009	Splt per Spk.	-0,378	0,357	-0,134	0,177
Seed per Spk	-0,623*	-0,717**	-0,633*	-0,584*	Seed per Spk	-0.361	-0,053	-0,256	0,010
Seed W.per Spk	-0,767**	-0,853**	-0,698**	-0,663**	Seed W.per Spk	-0,378	-0,279	-0,330	-0,133
Harvest Index	0,184	-0,176	-0,284	-0,370	Harvest Index	-0,208	-0,231	-0,318	-0,315
Yield	0,219	0,330	0,322	0,156	Yield	0,142	-0,397	-0,312	-0,330

Determinations in correlation between gliadin patterns and agronomic and quality traits are hard due to high molecular weight subunits of glutenin (Fido et al., 1997). Branlard and Dardevet (1985) found a negative correlation between ω gliadin and a number of quality traits. Whereas, positive correlation was found between γ gliadin subunit and gluten quality (Rashed et al., 2007). Significant positive effects of gliadin isoforms were found on agronomic traits and environmental adaptation (Metakosky and Branlard, 1998). Metakovsky and Branlard (1998) stated that genetic diversity in genotypes can be controlled by polymeric markers and electropheretic patterns of gliadin subunits in genotypes. Determination of gliadin subunits is therefore very useful not only in genotype idendification but in breeding programs (Bushuk and Zillman 1978; Persson and Von Bothmer, 2000).

So, quality and agronomic traits, and gliadin electrophoretic profiles revealed that comprehensive diversity occurs among genotypes. Determination of quality and agronomic traits in genotypes needs long-term measurements to reach reliable results and they are widely affected from environmental conditions (Vaquero ve ark., 1990; Metakovsky and Branlard, 1998; Ojaghi and Akhundova, 2010). Gliadin pattern of wheat genotypes are free from environment, they are easy and forceful method in evaluation of genetic materials, breeding programs, pure seed productions in hexaploid wheat. It is well known that yield is controlled polygenic activities and it is difficult to increase directly, however certain traits are significantly correlated with yield. Assigning and monitoring traits could help to increase yield and quality.

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