INVESTIGATION OF YIELD, YIELD COMPONENTS AND PRIMARY QUALITY CHARACTERISTICS OF SOME BREAD WHEAT (*TRITICUM AESTIVUM* L.) GENOTYPES

Mzhda Jalal ALI

MASTER THESIS

Department of Field Crops

Supervisor: Assoc. Prof. Dr. Hasan KILIÇ

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This thesis was unanimously approved by the following jury on 26.05.2017

Assoc. Prof. Dr. Hasan KILIÇ President of the Jury	Prof. Dr. Mehmet AYÇİÇEK Member	Assoc. Prof. Dr. Mehmet YILDIRIM Member

I confirm the result above

Prof. Dr. İbrahim Y. ERDOĞAN
Director of the institute

PREFACE

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This work is dedicated to my loving parents. Also, dedicated to my sisters especially (Aynda Gull) and brothers, and my loving aunt Aesha Hamad Sidiq. I dedicated to my lovely niece (Eilya).

Mzhda Jalal ALI

Bingöl 2017

CONTENTS

LIST OF ABBREVIATION

GAP IARTC	:	International Agricultural Research and Training Center- Diyarbakir
DTARI	:	Directorate of Trakya Agricultural Research Institute- Edirne
EMARI	:	Eastern Mediterranean Agricultural Research Institute- Adana
CIMMYT	:	International Maize and Wheat Improvement Center
ANOVA	:	Analysis of variance
CV	:	Coefficient of Variation
DF	:	Degree of Freedom
NIT	:	Near Infrared Transmittance
G	:	Genotype
SDS	:	Sodium Dodecyl Sulfate or Sedimentation Value
TKW	:	Thousand Kernel Weight
°C	:	Degree Celsius
hl	:	Hectoliter
%	:	Percent
g	:	Gram
kg	:	Kilogram
da	:	Decare
ha	:	Hectare
Mm	:	Millimeter
cm	:	Centimeter
m	:	Meter
m^2	:	Meter square
ml	:	Milliliter

pH	: Acidity
N	: Nitrogen
P_2O_5	: Phosphate
$CaCO_3$	: Calcium carbonate

LIST OF FIGURES

LIST OF TABLES

EKMEKLİK BUĞDAY (*TRITICUM AESTIVUM* L.) GENOTİPLERİNİN VERİM, VERİM UNSURLARI VE BAZI KALİTE ÖZELLİKLERİ YÖNÜNDEN DEĞERLENDİRİLMESİ

ÖZET

Bu çalışmanın amacı; bölgeye uygun verim ve kalitesi yüksek yeni ekmeklik buğday genotiplerini tespit etmek ile Diyarbakır ve benzeri ekolojilere sahip bölgelerdeki birim alandaki buğday verimi ile kalitesini artırmaktır. Araştırma, 2015-2016 vejetasyon döneminde Diyarbakır yağışa dayalı şartlarında yürütülmüştür. Araştırmada, GAP Uluslararası Tarımsal Araştırma ve Eğitim Merkezi'nden temin edilen 20 ileri hat ile Dinç, Pehlivan, Cemre, Tekin, Ceyhan-99 çeşitleri kullanılmıştır. Deneme "Tesadüf Blokları Deneme" desenine göre üç tekerrürlü olarak kurulmuştur. Çalışmada başta tane verimi olmak üzere başaklanma süresi, bitki boyu, bayrak yaprak klorofil içeriği, başak üst boğum uzunluğu, m^2'de başak adedi, başak uzunluğu, başakta başakçık adedi, başakta tane adedi, başakta tane ağırlığı, dane rutubet muhteviyatı, bin dane ağırlığı, hektolitre ağırlığı, protein oranı, SDS sedimantasyon hacmi ve yaş glüten içeriği gibi özellikler incelenmiştir. Genotipler arasında m^2 de başak adedi dışında incelenen özellikler bakımından önemli farklılıklar tespit edilmiştir. Elde edilen sonuçlara göre; Diyarbakır ve benzeri şartlarda tane verimi bakımından Tekin çeşidi ile G6, G16, ve G18 genotipleri iyi performans gösterirken, kalite özellikleri yönünden ise G1 ve G3 genotipleri ön plana çıkmıştır. Uygulanabilir bir tavsiye için denemenin farklı yıl ve lokasyonlarda tekrar edilmesi esastır.

Anahtar Kelimeler: Ekmeklik buğday, korelasyon, tane verimi, kalite, verim unsurları.

INVESTIGATION OF YIELD, YIELD COMPONENTS AND PRIMARY QUALITY CHARACTERISTICS OF SOME BREAD WHEAT (*TRITICUM AESTIVUM* L.) GENOTYPES

ABSTRACT

The aim of this study was to determine new wheat advanced lines with higher yield and better quality properties and to increase overall wheat production in Diyarbakir and surrounding regions with similar ecology. The experiment was carried out on 20 advanced lines and Dinç, Pehlivan, Cemre, Tekin and Ceyhan-99 as cultivars obtained from GAP International Agricultural Research and Training Center, during the growing season since 2015-2016 in the Diyarbakir, Turkey. The experiment was organized as randomized complete block design with three replications. Morphological and quality traits were considered: days to heading, plant height, chlorophyll content, peduncle length, number of spikes per square meter, spike length, number of spikelet per spike, number of grains per spike, grains weight per spike, grain yield, moisture content, thousand kernel weight, hectoliter weight, protein content, SDS sedimentation value, and wet gluten. There were significant differences among genotypes for all evaluated characters except number of spikes per m^{-2}. The results also showed that advanced lines G1 and G3 and had the highest values in terms of quality parameters. In terms of grain yield the variety Tekin and advanced lines G6, G16, and G18 had the highest yield. To give an acceptable recommendation, the experiment should be repeated in more number of environments.

Keywords: Bread wheat, correlation, grain yield, quality, yield components.

1. INTRODUCTION

Wheat is one of the important grain crops in the world and it has the widest distribution among cereal. The crop is mainly grown for its grain, which is used as human food (Kılıç 2015). Wheat is a source of nutrition for 35% of the world population, and actually ranks first among cultivated plants in terms of cultivation zone and production (Yağdı 2002). Wheat is one of the most important produces in Turkey, and the country ranks among the top ten producers in the world. Bread wheat is a staple and strategic crop, and an important food in the Turkish diet, consumed mostly as bread, but also as raw meatball, flat bread and cookies (Fao 2009). Wheat (*Triticum aestivum* L.) is a main cereal crop in many parts of the world and it is usually known as the king of cereals. It belongs to *Poaceae* family and globally, after maize and rice, is the most cultivated cereal (Faostat 2013). It is the first important cereal crop of Turkey and now calculation for about 68% of the total cereal production with coverage of 7.92 million hectares (TUIK 2014). Turkey has various climatic areas due to its geographical and topographical characteristics. Many agricultural schemes specific to particular agro-environmental regions have emerged in these areas. Highly productive cultivars have newly been developed in zones with extensive wheat cultivation. Moreover, a substantial number of 50-60-year-old cultivars with lowest productivity continue uncultivated (Şahin et al. 2006; Altay 2012). The zone available for wheat cultivation is becoming increasingly limited, but the demand for wheat continues to grow. For this reason, it is of energetic importance to select appropriate cultivars, suitable for growing in the zone, that offer maximum competence per unit area. Both the yield of the cultivars used in a region and the solid of their performance under the particular climate conditions of the culture are crucial features of the cultivars used commonly in the region, as they are important to ensure continuous productivity (Yağdı 2002). Yield, as a purpose of various components, is a multipart character. It was suggested that yield depends on the number of spikes per unit area, the number of grain per spike and the average grain weight (Poehlman 1994). The grain yield and yield components of wheat are affected very much by the genotype and the climate. Therefore, as new cultivars are being produced by breeding, the contacts between yield and its components are studied by the breeders. To increase the yield, research of direct and indirect effects of yield components supply the basis for its successful breeding program and hence the problem of yield increase can be a lot successfully tackled on the basis of performance of yield components and selection for carefully related characters (Chowdhry et al. 1986). Formerly, high yielding ability and appropriateness for farmers' own food needs were the only factors relating in the participatory plant breeding. This approach neglected to give special attention for industrial and specific end use quality in southeast Anatolia. Industrial and the end use quality mean different things to a consumer, a miller, a baker, a grain handler or a plant breeder. As the baking industry becomes increasingly specialized, specific qualities are researched Grain shoppers sometimes mixture the wheat to obtain a suitable stability for a specific end use by (Edwards 1997). Wheat quality is a very wide subject that will be defined differently by the different organization of the wheat chain, which makes it an extremely complex and variable idea. For farmers in some countries wheat quality is considered what allows them to give their harvested grain at the grain market and get the highest price for it. This is usually different between countries, where each one has different rules that may major farmers for producing better grain quality or not (Blakeney et al. 2009). The objectives of the study were to determine the genotypic variation with agronomic performance with rainfed condition among diverse bread wheat genotypes based on agronomic traits and to identify promising advanced lines for region.

2. LITERATURE REVIEW

The opinion of specific adaptability of genotypes explains that the fact of a genotype performing well in 1 environment and not in another even if the differences between 9 locations are depend from year to year (Fehr 1987).

This research was conducted a three year trial on 13 winter bread wheat varieties representing very old, old, less old and modern groups. It was observed that modern varieties produced near 60% more grain yield than the very old varieties, 14% more spikes per square meter, and 30% more grains per spike. New varieties headed 6 days earlier than old ones and produced more biomass (Austin et al. 1989).

Altitude and climatic factors play an important role in the distribution of wheat production through their influence on pests and diseases damage, rainfall and temperature. Areas located in the altitude range between 1900-2300m are suitable only for intermediate season verities whereas areas between 1500- 1900 m are favorable to early and intermediate maturing varieties. The effectiveness of different wheat diseases varies agro climatic (altitude and temperature, precipitation etc) factors. For example yellow rust mainly limited to high altitude and cooler areas (Gebremariam 1991).

Environmental factors such as growing seasons, locations, years, the amount of precipitation received in growing season, rainfall duration, temperature, etc. may have positive or negative effects on genotypes performance. Two types of environmental variations: (1) micro environmental which cannot easily be defined or estimated (drought conditions, year-to-year variation in rainfall, grade of the insect damage) and (2) macro-environmental variances which can be identified or estimated (soil type, agronomic practices, and controlled climate conditions) (Mather and Jinks 1982; Mukai 1988; Wu and O'Malley 1998).

Grain yield is the most complex parameter which affected by several biotic and abiotic stress factors that determine productivity (Araus et al. 2001). Among the several factors, yield related traits have high impress on grain yield that can be acquired. Some of the yield related traits are days to flowering, days to maturity, plant height, thousands grain weight, number of kernels per tiller and test weight. These parameters affect yield positively and or negatively; their effect on yield depends on the influence of environment on these traits. As a result, knowing about the inheritance and interrelation of grain yield and yield related components are highly important (Garcia del Moral et al. 2003).

In a study, to determine the yield characteristics of some bread wheat cultivars under Ankara conditions; plant height typical for the first year has been reported as 86.5 cm, and 108.0 cm second year, thousand kernel weight average for the first year has been reported 42.2 g, and 32.9 g for the second year, unit area grain yield average has been reported as for the first year 313.0 kg/da and 518.6 kg/da for the second year, while harvest index average for the first year was 23.6%, and 40.3% for the second year (Kaya 2004).

The grain yield of wheat is variable parameter, which depends on numerous yield components and environmental factors (Kraljević-Balalić et al. 2001). According to (Užík and Žofajová 2006; Knezevic et al. 2007) environmental conditions (total precipitation, drought, high and low temperature) have effect on the efficiency of fertility, capacity of assimilation acceptors, grain filling and translocation of assimilates from stalk and leaves to the grain. Also, environmental factors such as drought stress may occur throughout the growing season, early or late season, but its effect on yield reduction is highest when it occurs after anthesis (Blum 2005).

In a study, to determine the yield and quality characteristics of 25 bread wheat genotypes under middle Black Sea conditions the average figures ranged as follows: the grain yield were 345.0 kg/da in Samsun and 486.3 kg/da in Amasya, thousand kernel weight ranged between 25.9-38.3 g in Samsun and 27.8-36.9 g in Amasya, hectoliter weight ranged between 63.8-71.8 kg in Samsun and 73.1-80.2 kg in Amasya, sedimentation amount were 38.3 ml and protein content was 11.2% (Aydın et al. 2005).

In a research, grain yield, plant height, thousand kernel weight, hectoliter weight, crude protein content and Zeleny sedimentation value of genotypes, were between 284.4-490.6 kg/da, 66.9 – 98.8 cm, 28.4 – 38.9 g, 68.4 – 74.9 kg, 10.4 – 13.6% and 25.0 – 50.6 ml, respectively. The highest seed yield was obtained from 16, 22 and 23 numbered genotyped in Samsun location, while 1, 6, 7, 9, 10, 12 and 16 numbered genotypes provided the highest grain yield in Gökhöyük location (Mut et al. 2005).

Grain yields in genotypes under study changed during 388.17-655.83 kg/da. Sana and Mv-17 varieties provided the highest grain yield. ISWYN-14 and IBWSN-58 lines were determined as promising lines. Saraybosna and Sana produced the lowest plant height. The highest averages spike length were obtained from the genotypes of ISWYN-24, Bezostaja-1, IBWSN-42, Kate A-I, Miryana and ISWYN-29. The highest averages of the number of grains per spike were measured for the genotypes of IBWSN-62, Mv-17, Sana, Kate A-I, Prostar and IBWSN-42, respectively (Bilgin et al. 2005).

The correlation coefficients and path analysis were calculated between grain yield and yield components of 20 bread wheat genotypes with the trials conducted across two locations and over two years. Significant and positive correlation was found between plant density and yield, plant height, grain number per spike, grain weight per spike and thousand kernels weight. Grain yield was negatively and significantly connected with heading time. Positive direct effect of plant height and grain weight spike^{-1} and negative direct effect of time to heading associated with significant correlation with grain yield, they suggested that these yield components probably will be good selection standards to improve yield of wheat genotypes (Aycicek and Yildirim 2006).

Bread wheat (*Triticum aestivum* L.) is an important crop global and is grown on about 200 million hectares in a range of environments, with annual production of more than 600 million metric tons (Fao 2006).

In a research, twenty five bread wheat genotypes five varieties and twenty lines were used as materials. Experiments were carried out in Samsun and Amasya locations during 2004-2005 growing season. The genotypes were evaluated in this research, some quality characteristics of thousand kernel weight, test weight and protein content of the genotypes as the average of two locations were as follows 32.4-43.2 g, 76.5-81.4 kg, 12.4-13.3%, respectively (Aydın et al. 2007).

Three bread wheat cultivars (Pehlivan, Flamura-85 and Golia) with different plant height and growing period usually grown in Trakya region. Based on the results of this study, main stems of all cultivars had the highest plant height, spike length, the number of spikelet per spike, the number of grain per spike, the grain weight per spike and thousand kernel weight. The highest plant grain yield was obtained from plants with four tillers including main stem. Plants with no tiller (only main stem) had the lowest plant grain yield (Gençtan et al. 2007).

According to two year average grain yield and some yield components of 16 bread wheat variety (Tir, Bezostaja, Gerek-79, Kutluk-94, Kırgız-95, Süzen97, Aytin-98, Harmankaya-99, Altay-2000, DağdaĢ-94, Lancer, Doğu-88, Karasu-90, Palandöken-97, Nenehatun and Alparslan). Days to headings ranged between 180.75 (Aytin-98) and 190.62 (Karasu-90) days; grain filling duration, 33.12 (Lancer) - 39.25 (Gerek-79 and Alparslan) days; spike number per m^{-2}, 265.2 (Tir) - 412.2 (Doğu-88), spike length, 5.72 (Aytin-98) - 7.27 (Nene Hatun) cm; plant height, 66.0 (Harmankaya)- 86.05 (Tir) cm; grain number per spike, 20.32 (Gerek-79) - 27.47 (Harmankaya); grain weight per spike, 0.65 (Alparslan) - 0.93 (Harmankaya) g; thousand grain weight, 29.26 (Aytin-98) - 37.45 (Tir) g; grain yield, 167.07 (Tir) - 238.36 (Doğu-88) kg/da. It was concluded that Doğu-88, Nenehatun and Alparslan bread wheat cultivars were promising cultivars in Van regional conditions (Yağmur et al. 2008).

Further study conducted in Turkey and they used 14 bread wheat varieties, 12 of which were introduced into their investigation from Romania, were evaluated for grain yield and 7 agronomic properties in Biga, Çanakkale in northwest part of Turkey in two different growing seasons. Based on a two-year data, all the characteristics examined showed significant difference and varied with a wide range in grain yield, plant height, spike length, number of spikelets and thousand kernel weight. Except for harvest index, genotype x year interactions (GxY) was found to be significant for all the traits studied. Correlation coefficient analyses revealed that the grain yield had positive and significant associations with plant height, grain weight per spike, number of grain per spike and 1000 grain weight.

Consequently, local varieties compared to new bread wheat varieties, Joseph followed by Dumbrava and Trivale, from Romania showed lower yield so it is better to use these new varieties (Tayyar 2008).

Bayoumi et al. (2008) who observed that drought caused reductions in days to 50% heading, plant height, number of tillers, spike length, thousand kernel weight, biological and grain yield and harvest index by 4.78, 14.7, 36.3, 23.7, 16.4, 32.9, 43.2, and 12.7% of control, respectively.

In a research, grain yield and quality traits of 25 different winter bread wheat varieties were compared in two different locations as Elazığ and Malatya in 2001-2003 growing seasons. It was studied grain yield and quality traits. It was established that the grain yield of the varieties were affected differently by different locations and growing seasons. The result showed that Yakar (250.4 kg/da and Altay-2000 (248.3 kg/da) were found to be highest yielding cultivar in Elazığ in extreme low rainfall condition in 2002/2003 season. However, Gün-91 (650.8 kg/da) was to be highest yielding cultivar in 2003/2004 season (Kılıç et al. 2008).

Ali et al. (2008) reported that seventy local and exotic wheat genotypes grown in Faisalabad, Pakistan during the Rabi season of 2005/2006 were evaluated for variability parameters. They projected high heritability for plant height, spikelets spike, spike length, grain spike, thousand kernel weight and yield per plant. These traits also indicated high genetic advance. Significant genotypic differences were observed for all the traits studied indicating considerable amount of variation among genotypes for each character. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were high for yield per plant, number of productive tillers per plant and number of grains per spike.

In a study conducted in Faisalabad, Pakistan during season of 2005-2006. 70 Wheat varieties from different National Yield Trials at different places and CIMMYT were evaluated for variability parameters. It has been observed variation among cultivars; plant height was 64.57-120.17 cm, number of productive tillers was 5.33-24 and thousand grain weight 32.3-56.92 g (Ali et al. 2008).

In a three year study in Pakistan, seven wheat cultivars (Bhakhar2002, Inqulab91, Shafaq2006, AS2002, Sehar2006, Auqab2000 and GA2002) were studied for their quality characters. The result for the parameters was 77-81 kg/hl for test weight, 37-41 g for thousand kernel weight, 9.11-9.79% for moisture content (Safdar et al. 2009).

Wheat (*Triticum aestivum* L.) is a hexaploid (2n = 6x = 42 = AABBDD genomes), annual and self-pollinated cereal which is grown global. It belongs to tribe "Triticeae" of the family *Gramineae*. Wheat is a monoecious plant with perfect flowers, reproducing sexually as an autogamous crop although limited (3%) cross pollination is possible. Similar to many crops of the Old World, wheat was one of the first domesticated food crops which was evolved in the Fertile Crescent of the Middle East and has become a basic main food of the present day human population (Mergoum et al. 2009).

The experiment was conducted at seven ecological conditions during 2 growing stages (2003-2004 and 2004-2005. The result showed that out of the total sum of squares, 48.4, 28.0 and 23.6% for TKW, 71.4, 14.9 and 13.7% for hectoliter weight, 54.4, 23.0 and 22.6% for GPC, 44.7, 41.7 and 13.6% for sedimentation volume was attributable to E, G and G x E interaction effects, respectively. Thousand kernel weight, hectoliter weight, grain protein content and Zeleny sedimentation volume of genotypes changed from 34.5 to 41.4 g, from 76.5 to 80.4 Kg, from 11.49 to 13.37% and from 22.1 to 46.0 ml, respectively (Mut et al. 2010).

Mohammadi Gonbad et al. (2010) by exploring the relations between yield and its components in bread wheat genotypes under condition of heat stress displayed that in a favorable conditions spike number per m^2 had the highest positively direct effect on grain yield, whereas in an critical condition biomass had the highest positively direct effect on grain yield among the study traits.

In a research, five bread wheat cultivars and five durum wheat cultivars developed at the Maize Research Institute Zemun Polje, Serbia were compared based on their agronomic characters. The total protein content ranged from 9.26-12.64% and gluten (soluble + insoluble) 29-43.8 for bread wheat varieties, for durum wheat 11, 04-12.40% protein and gluten (soluble + insoluble) 27.35-39.45 (Žilić et al. 2011).

In a study, varieties Bakalcha, Ejersa, Ude and Metaya that showed relatively better and similar yield performances, the remaining genotypes showed inconsistent performances across the tested environments. This indicated that a need to develop cultivars that are adapted to a wide or specific environmental conditions and the need to assess the stability of genotypes across more locations over a season but this experiment evaluated thirteen genotypes at four locations in a single cropping season. Therefore, to give a strong recommendation, the experiment should be repeated in more number of environments (Abate 2011).

Wheat (*Triticum* spp.) is one of the greatest important food crops in the world in terms of the area harvested, production and nutrition; as it supplies about 19% of the calories and 21% of the protein to the world's population (Fao 2011).

In a research, variation range for yield, some yield components and quality traits of some durum wheat lines selected among pilot yield trials in Diyarbakir ecological environments during 2008-2009 growing season. Mean values of the lines improved between 118.9 - 131.7 day for heading time; 99.2 - 142.6 cm for plant height; 60.4 - 78.5 kg/hl for test weight; 20.7 - 33.1 g for thousand grain weight; 10.96 - 15.76% for grain protein content; 52.89 - 71.33% for PSI value; 3.97 - 14.5 ml for mini SDS and 242.6 - 445.2 kg/da for grain yield (Kılıç et al. 2012).

It was found out that grain yield ranged between 5809-7820 kg/ha, the highest grain yield was obtained from G3, G7, G11 and G12 genotypes, while the lowest grain yield was obtained G22 genotype (5809 kg/ha). Hectoliter weight is a quality factor, and in terms of test weight the highest value was obtained from G14 genotype (82.4 kg/hl), while the highest protein content was obtained with 11.9% in G17 genotype (Doğan et al. 2012).

The study was conducted out to determine the effects soil structure on yield and some quality factors such as protein, starch, ash of bread wheat (*Triticum* sp.) were observed in Cukurova Region. The highest yield was obtained at control parcel which disturbed soil structure of Ceyhan-99 variety as 6100.0 kg ha^{-1}. The yield was 5253.3 kg ha^{-1} in parcel 1 in which undisturbed soil structure of Adana-99 variety and increased to 5621.6 kg ha^{-1} in control parcel. Also yield was 5910.0 kg ha^{-1} in parcel 1 in which undisturbed soil structure of Ceyhan-99 variety and increased to 6100.0 kg ha^{-1} in control parcel which disturbed soil structure. Similar of disturbed soil structure were also effective on thousand kernel weight. While thousand kernel weight of disturbed soil of Ceyhan–99 variety was 36.16 g, the thousand kernel weight of plot 1 which undisturbed soil structure realized as 35.76 g. (Irmak et al. 2012).

The top 10 wheat producing countries in the world are: China (120.58 Mt), India (94.88 Mt), United States (61.76 Mt), France (40.3 Mt), Russia (37.72 Mt), Australia (29.91 Mt), Canada (27.01 Mt), Pakistan (23.47 Mt), Germany (22.4 Mt) and Turkey (20.1 Mt) (Faostat 2013).

In a study, 14 wheat cultivars (Kiran-95, Amber, Sindh-90, Sarsabz, Khirman, Jauher-18, Mehran-89, Anmol-91, TJ-83, GP-256, GP-205, Marvi, and Soghat) collected from Nuclear Institute of Agriculture (NIA) and one unknown from local market. These variety were compared in their total protein, crude protein and gluten in order to indicate the best wheat cultivar in baking quality and with good nutrition status. The cultivars varied in these quantitative properties; total protein 15.42-8.28%, crude protein 88-15% and gluten 43-50.43% (Khan et al. 2013).

In Diyarbakir ecological environments in 2004-2005 and 2005-2006 winter plant growth seasons, it was found out that bread wheat grain yield ranged between 5145 and 8209 kg ha^{-1}. The highest grain yield was obtained from the genotype 18, while the lowest grain yield was obtained from the genotype 3 (5145 kg ha^{-1}). In terms of hectoliter weight, the highest value was obtained from the genotypes 19 and 24 (81.8 kg) while the highest protein content (11.9%) was obtained from the genotype 1. According to the results of this study, it was seen that some genotypes (9, 17, 18, 19 and 24) obtained from abroad were found to be promising in terms of yield and quality characters (Doğan et al. 2013).

In a study, it was used 17 bread wheat lines which is selected from regional yield trials of bread wheat and eight cultivars (Basribey-95, Kaşifbey-95, Pamukova-97, Tahirova-2000, Adana-99, Sakin, Nurkent and Canik-2003) in order to control grain yield and some quality traits under environmental condition of South Eastern Anatolia. The experiments was conducted in 2004-2005 growing seasons in Diyarbakir and Ceylanpınar place under rain fed conditions. Grain yield in Diyarbakir location was between 382.3-606.7 kg da^{-1} while it was determined as 95.0-391.3 kg da^{-1} in Ceylanpınar location (Kılıç et al. 2014).

Wheat is cultivated in every land except Antarctica. It is developed at a wide elevation range from 260 m below sea level (Jordan Valley) up to 4,000 m above sea level (Tibetan plateau) (Kew 2014). The crop is grown under a wide range of climactic environments and geographical areas and due to this; its distribution range is more than any other plant species.

It is obvious that wheat is the top field crop throughout the world and Turkey is one of them. For wheat production, Turkey has a suitable ecology and is part of the center of origin for wheat. Hence, Turkey has advantages for the development of productive high-quality varieties of wheat in terms of a nationally strategic crop (Mazid et al. 2015).

In Turkey, wheat production was just less than 2.5 million tons in the 1930s, reached 10 million tons in 1967 and 20.6 million tons in 2009. The increase in production was mainly because of the increased the areas of planting from the 1930s to 1960s. In addition to that, the grain yield per unit area was 920 kg per hectare in 1930 and reached 1250 kg per hectare 1967. Between 1967 and 2010, the increase in planting areas was only 1.0%, but the increase in grain yield was 104.8%. This yield increase was understood by significant contributions in both genetic values of the varieties used and improved agronomy, irrigation as well as fertilization (Gummadov et al. 2015).

The study projected ecological genetic gain for yield and other traits in winter wheat released for irrigated in Turkey from 1963 to 2004. Yield trials including 14 varieties were grown in sixteen environments from 2008 to 2012 in provinces of Konya, Eskişehir, Ankara and Edirne. The highest yields were obtained by recent varieties Kinaci-97 (5.48 t ha^{-1}), Cetinel-2000 (5.39 t ha^{-1}), Alpu-2001 (5.44 t ha^{-1}), Ahmetaga (5.35 t ha^{-1}) and Ekiz-2004 (5.42 t ha^{-1}) compared to older varieties Yektay-406 (4.17 t ha^{-1}) and Bezostaya-1 (4.27 t ha^{-1}) released in the 1960s. The development reached in grain yield in 20 years was 1.16 t ha^{-1} or 58 kg ha^{-1} (1.37%) per year. This gain was mainly achieved through shorter plant height and increased harvest index (Gummadov et al. 2015).

This research was carried out to characterize both 25 Turkish bread wheat cultivars and 200 pure lines selected from Turkish bread wheat landraces based on three grain quality traits [thousand kernel weight (TKW), protein content (PC), Zeleny sedimentation test (ZSDS)] as well as 5 mixograph parameters to investigate the diversity present among the pure lines. Their outcomes showed that, based on the quality traits, the pure lines in different groups were belonged to different provinces of Turkey. They were also proved to be highly diverse for 8 quality trait values to breeders and end-users. Especially most of the pure lines had higher PC, midline peak value of mixogram (MPV), midline time x = 8 min integral of mixogram (MTxI) and ZSDS values than some of the cultivars (Akcura et al. 2016).

The correlation coefficients of yield with other morpho-physiological traits were also partitioned into direct and indirect effects to find out a suitable trait that could be used for the yield improvement of spring wheat (Rahman et al. 2016).

3. MATERIAL AND METHOD

3.1. Material

3.1.1. Description of experimental site

The study was carried out in the experimental area of the GAP International Agricultural Research and Training Center in Diyarbakir, Turkey. The experimental station is located at 37º55’36" N and 40º13’49" E at 670 m above sea level (Figure 3.1).

Figure 3.1. Location of the experimental site

Figure 3.2. Image of early season of experimental plots

Figure 3.3. Image of late season of experimental plots

This research was twenty five bread wheat (*Triticum aestivum* L.) genotypes (5 Turkish varieties and 20 advanced lines) from the bread wheat breeding program of GAP International Agricultural Research and Training Center, were grown under rainfed condition during the growing season since 2015-2016 in the Southeastern Anatolia, Diyarbakir, Turkey. Information on varieties and advanced lines are given in (Table 3.1).

Figure 3.4. Image of an experimental plot during flowering period

Table 3.1. Description of twenty five bread wheat genotypes grown in 2015-2016

Genotype No:	Variety name and Advanced Lines	Registration Year	Origin	Grain Color
G1	NAC/TH.AC//3*PVN/3/MIRLO/BUC/4/2*PASTOR/5/... CMSS06B00734T 099TOPY-099ZTM-099Y 099M-13WGY-0B			White
G2	CHIBIA//PRLII/CM65531/3/SKAUZ/BAV92/4/… CMSS07Y00066S-0B-099Y-099M-099Y-38M-0WGY			White
G3	KACHU/KIRITATI CMSS07Y00127S-0B-099Y-099M-099NJ-099NJ- 6WGY-0B			White
G4	BAJ#1/3/KIRITATI//ATTILA*2/PASTOR CMSS07Y00288S-0B-099Y-099M-099Y-17M-0WGY			White
G5	**DİNÇ**	**2013**	**GAP IARTC**	**White**
G6	WBLL4/KUKUNA//WBLL1/3/WBLL1*2/BRAMBLING CMSS07Y00348S-0B-099Y-099M-099Y-19M-0WGY			White
G7	TACUPETO F2001*2/KIRITATI//VILLA JUAREZ F200… CMSS07B00094S-099M-099NJ-099NJ-16WGY-0B			White
G8	CHIBIA//PRLII/CM65531/3/SKAUZ/BAV92/4/… CMSS07Y00066S-0B-099Y-099M-099Y-8M-0WGY			White
G9	KIRITATI/WBLL1//FRANCOLIN#1 CMSS07Y00174S-0B-099Y-099M-099Y-10M-0WGY			White
G10	**PEHLİVAN**	**1998**	**DTARI**	**Red**
G11	KIRITATI/WBLL1//FRANCOLIN#1 CMSS07Y00174S-0B-099Y-099M-099Y-22M-0WGY			White
G12	PFAU/SERI.1B//AMAD/3/WAXWING/4/BAJ#1 CMSS07Y00195S-0B-099Y-099M-099Y-5M-0WGY			White
G13	FRANCOLIN#1*2/HAWFINCH#1 CMSS07Y00935T-099TOPM-099Y-099M-099Y-17M-0WGY			White
G14	WBLL1/KUKUNA//TACUPETO F2001*2/6/PVN//… CMSS07Y01070T-099TOPM-099Y-099M-099Y-20M-0WGY			White
G15	**CEMRE**	**2008**	**GAP IARTC**	**White**
G16	KACHU*2/BACEU#1 CMSS07Y01075T-099TOPM-099Y-099M-099Y-17M-0WGY			White
G17	HUIRIVIS#1/MUU//WBLL1*2/BRAMBLING CMSS07Y01144T-099TOPM-099Y-099M-099NJ-099NJ-7WGY			White
G18	PRL/2*PASTOR//DANPHE#1 CMSS07B00010S-099M-099Y-099M-28WGY-0B			White
G19	WBLL1*2/3/YACO/PBW65//KAUZ*3/TRAP/4/… CMSS07B00220S-099M-099Y-099M-22WGY-0B			White
G20	**TEKİN**	**2014**	**GAP IARTC**	**White**

Table 3.1 Continue

G21	KAUZ*3/MNV//MILAN/3/BAV92*2/4/KBIRD CMSS07B00578T-099TOPY-099M-099Y-099M-23WGY-0B			White
G22	WBLL4/KUKUNA//WBLL1*2/3/KINGBIRD#1 CMSS07B00693T-099TOPY-099M-099Y-099M-24WGY-0B			White
G23	ND643/2*WBLL1//ATTILA*2/PBW65/3/MUNAL CMSS07B00807T-099TOPY-099M-099NJ-099NJ-1WGY-0B			White
G24	38IBWSN-208			White
G25	**CEYHAN-99**	**1999**	**EMARI**	**White**

GAP IARTC: GAP International Agricultural Research and Training Center- Diyarbakir; DTARI: Directorate of Trakya Agricultural Research Institute- Edirne; EMARI: Eastern Mediterranean Agricultural Research Institute- Adana.

3.1.2. Description of bread wheat variety used for the study

Dinç is a **s**pring bread wheat variety which was first registered in 2013 from Diyarbakir, it was grown by the GAP International Agricultural Research and Training Center, Dinç breeding method was done by selection. The characteristics of Dinç stem and leaf are semi-draft, resistant to lodging, the stem is strong. The structure of it's spike is short and white and stringy shape, waxy. The grain is white. The average yield in optimum conditions is 3000 kg/ha, but yield potential can be rise up to 8740 kg/ha. The disease situation is that it is tolerant against yellow rust. It is performed in Southeastern Anatolia Region's rainfed and irrigated conditions. Technological Characteristics:

1. Hectoliter Weight (kg/hl) 77.1-82
2. Protein (%) 12-16
3. Sedimentation Value (%) 30-45
4. Energy Value (%) 100-175
5. Yield Flour (%) 58-64
6. Water Absorption (%) 61-66

Pehlivan is a winter bread wheat variety released in 1998. It was grown by the Directorate of Trakya Agricultural Research Institute (pedigree: Bez /Tvr/5/Cfn/Bez// Suw92/ CI13645/ 3/ Nai60/ 4/Emu"S", cross ID and selection history - TE2376-6T-1T- 3T-0T). It has a medium early growth cycle. The spike is white, smooth, awnless and compact, and the plant height is 95-100 cm. The variety has high productive tillering with high winter hardiness to be grown in winter wheat areas of the Central Anatolian Plateau, with a medium tolerance to drought. It has medium resistance to powdery mildew but is susceptible to leaf rust and root rot. Given its height, Pehlivan also has medium opposition to lodging. The grain yield potential is high, about 5000-7000 kg/ha. It is suitable for growing on fertile and poor fertile soils, and is grown in most wheat producing regions of Turkey. The grain is oval, hard-red, very large, and has good milling and baking qualities. Technological Characteristics: (Mazid et al. 2009).

1. Hectoliter Weight (kg/hl)	78-82
2. Protein (%)	12-14
3. Sedimentation Value (%)	35-45
4. Energy Value (%)	190-220
5. Water Absorption (%)	60-65
6. Gluten (%)	35-45
7. Gluten index (%)	60-70

Cemre is one of the spring bread wheat variety which was first registered 2008 in Diyarbakir, it was developed by the GAP International Agricultural Research and Training Center, Cemre breeding method was done by selection. The characteristics of Cemre stem and leaf are medium height plant, the leaves are featherless as well as wide and long, resistant to lodging, the stem is strong, low waxy of flag leaf. The structure of its spike is long and white and stringy shape. The grain is white. Average yield in best situations is 4500 kg/ha, but yield potential can be increase to 8500 kg/ha. The disease condition is that it is tolerant against yellow root rot. It is done in Southeastern Anatolia Region’s rainfed and irrigated situations. Technological Characteristics:

1. Hectoliter Weight (kg/hl)	71.4-80.5
2. Protein (%)	12-17
3. Sedimentation Value (%)	30-59
4. Energy Value (%)	144-316
5. Yield Flour (%)	58-63
6. Water Absorption (%)	61-66

Tekin is one of the spring bread wheat variety which was first registered 2014 in Diyarbakir, It was grown by the GAP International Agricultural Research and Training Center, Tekin breeding method was done by selection. The characteristics of tekin stem and leaf are medium height plant. The structure of its spike is medium height and white stringy shape, slowly contraction and waxy. The grain is white, semi-strong Average yield in optimum situations is 600 kg/ha, but yield potential can be increase to 800 kg/ha. The disease situation is that it is tolerant yellow rust. It is done in Southeastern Anatolia Region's rainfed and irrigated conditions and coastal zones. Technological Characteristics:

1. Hectoliter Weight (kg/hl)	79-84
2. Protein (%)	12-16
3. Sedimentation Value (%)	32-60
4. Energy Value (%)	120-250
5. Yield Flour (%)	60-70
6. Water Absorption (%)	60-68

Ceyhan-99 is one of the important spring bread wheat variety registered in 1999. It was developed by Eastern Mediterranean Agricultural Research Institute in Adana from germplasm provided by CIMMYT (pedigree: BJY"S"/ COC; cross ID and selection history: CM55651- 4Y-2Y-1M-4Y-0M). The variety is recommended for cultivation in rainfed areas and has been grown in Eastern Mediterranean Agricultural Research Institute region since 1999, and in other spring bread wheat growing regions of Turkey. Ceyhan-99 is medium early growing with good resistance to lodging, cold and drought in the region where it is grown. Ceyhan-99 is resistant to yellow rust, and septoria, and is also ascetically resistant to leaf rust. It is fit for growing on fertile and less fertile soils and the grain yield is 5000-8000 kg/ha. It has good grain and bread-making qualities. Technological Characteristics: (Mazid et al. 2009).

1. Hectoliter Weight (kg/hl)	77-78
2. Protein (%)	14-15
3. Sedimentation Value (%)	42-44
4. Softening value	60
5. Thousand kernel weight (g)	32-34

3.1.3. Climate Conditions of the Study Area

Monthly rainfall during the experimental year and the monthly average rainfall over the long term is shown in Table 3.2. Rainfall over the growing period in 2015-2016 was lower than the long term average. The highest monthly rainfalls (84.2 mm) were in October 2015.

Table 3.2. Monthly and long term averages of the climatic data in the experimental area

Years	Months	Max temp. °C		Min temp. °C		Moisture %		Rainfad mm	
		Long term	2015-2016	Long term	2015-2016	Long term	2015-2016	Long term	2015-2016
2015	September	33.9	36.2	15.5	17.8	31	25.7	2.6	0
	October	33.4	25.1	9.5	12.4	48	58.1	30.8	84.2
	November	15.1	17.3	4.7	3.1	68	59.8	54.6	10.4
	December	8.6	11.5	-0.4	-2.6	77	60.9	74.4	31.6
2016	January	6.8	5.1	-2.23	-2.8	77	79.3	74.6	77.4
	February	8.9	13.8	-1.5	2.3	73	71.7	68.4	69.2
	March	14.8	14.5	2.05	3.2	66	66.1	66.2	55.6
	April	20.5	23.7	6.28	7.1	63	56.2	73.5	29
	May	27	27.5	10.8	11.6	56	51.9	40.8	41.4
	June	33.7	34.7	16.8	17.3	34	32	7.2	18.4
	July	38.1	39.2	21.9	22.5	27	23	0.7	0
	August	38	40.5	20.5	22.1	27	22.7	0.6	0.2
	Total-Average	23.23	24.09	8.66	9.5	53.9	50.6	494.4	417.4

Source: General Directorate of Meteorology in Diyarbakir.

3.1.4. Soil preparation

The soil in the experiment field according to the results of soil analyses conducted by the Soil Laboratory of the GAP International Agricultural Research and Training Center was silty-clay with pH of 7.86, organic matter content of 1.33%. The experimental field was flat with a slope less than 2%. Some physical and chemical properties of the experimental field soil are given in Table 3.3.

Table 3.3. Soil preparation of the experiment site

Location	Soil structure	Total Salt (%)	pH	Lime $CaCO_3$ (%)	Available P (P_2O_5) kg da^{-1}	Organic Matter (%)	Saturation (%)
Diyarbakir	silty-clay	0.060	7.86	13.13	2.36	1.33	64

3.2. Method

3.2.1. Treatments and experimental design

The study was carried out in the experimental area of GAP International Agricultural Research and Training Center in Diyarbakir, Turkey. The experiment was conducted in a randomized block design with three replications. Plot size was 7.2 m^{-2} (1.2 × 6 m), the planting depth was 5 cm. The plot size was 6 m length with 6 rows and row spacing was 20 cm. Genotypes were sown at the seed rate of 400 seed m^{-2} sowing time in the 13 November 2015 and harvested in the 23 June 2016. The plots were fertilized with 60 kg/ha^{-1} N and 60 kg/ha^{-1} P_2O_5 at the planting and 60 kg/ha^{-1} N in spring at stem elongation for drought conditions.

Days to heading, plant height, chlorophyll content, peduncle length, number of spikes per square meter, spike length, number of spikelet per spike, number of grains per spike, grains weight per spike, grain yield, moisture content, thousand kernel weight, hectoliter weight, protein content, SDS sedimentation value, and wet gluten of the genotypes were evaluated in this research.

Figure 3.5. Sowing time

3.2.2. Data collected and measurements

Data was collected from the central six harvestable rows for traits estimated from plot base and from randomly taken plants for traits to be collected on plant base. The following data were collected.

Days to heading (day): Number of days from emergence date at 27 November 2015 to 50% of the spikes have fully emerged.

Plant height (cm): The average height of five randomly sampled plants in (cm) from the ground level to the top of the spike excluding awns.

Figure 3.6. Image of plant height measured an experimental plot during maturity period

Chlorophyll content (SPAD): Chlorophyll content at flowering 50% (growth stage, GS61) on the midpoint of flag wide leaf of ten plants taken at random in each plot, were recorded by a portable chlorophyll meter (Minolta SPAD-502, Osaka, Japan is given in (Figure 3.7) further referred to as SPAD reading SPAD measurements, which are a measure of relative greenness, range from 0 to 100 SPAD values and are proportional to leaf chlorophyll content. The growth stages (GS) of winter wheat are defined by a decimal code developed by Zadoks et al. (1974).

Figure 3.7. Chlorophyll content measured at anthesis by Minolta spad meter

Peduncle length (cm): Peduncle length in each plot was recorded on 5 randomly selected plants in the center rows of each plot and their average was used.

Number of spikes per square meter: The number of spikes per square meter was calculated by counting the spikes contained in 1 m of two of the central rows in each plot.

Spike length (cm): The average length of the spike from base to the tip excluding the awns from ten randomly taken plants in each experimental unit.

Number of spikelet per spike: The average number of spikelet per spike is taken from ten spikes randomly.

Number of grains per spike: The average number of kernels in main tillers in each of the ten spikes is taken randomly.

Grains weight per spike (g): The sample size for counting number grain weight per spike is 10 spikes randomly in the stage of full maturity. Grains weights were obtained from spike of the sample plants weighted and averaged over per spike.

Grain yield (kg/ha^{-1}): Grain yield in kilogram per hectare was calculated from the yield harvested from each plot.

Thousand kernel weight (g): After the harvesting the wheat is extracted, 400 grain wheat is measured by (seed counter Contador) then the weight is taken this weight is multiplied by 2.5. Then the average was recorded.

Figure 3.8. Thousand kernel weight measured by machine seed counter contador

Whole grain quality characters: Quality characters are analyzed by the Whole Grain Analyzer (NIT) instrument that principles described by Maghirang et al. (2006) and Dowell et al. (2006). Whole grain quality characteristics included moisture content, hectoliter weight, protein content, SDS sedimentation value, and wet gluten. All whole grain quality characteristics were analyzed by Perten Whole Grain Analyzer-IM 9500 (Perten Instruments, Springfield, Illinois, USA) (Figure 3.9).

Figure 3.9. Whole grain Analyzer-IM 9500

Moisture content (%): The moisture contents (%) of all the wheat samples were determined by near-infrared transmission (NIT) on whole kernels using the Perten Whole Grain Analyzer-IM 9500.

Hectoliter weight (kg/hl): The hectoliter weight (kg/hl) of all the wheat samples was determined by near-infrared transmission (NIT) on whole kernels using the Perten Whole Grain Analyzer-IM 9500.

Protein content (%): The protein contents (%) of all the wheat samples were determined by near-infrared transmission (NIT) on whole kernels using the Perten Whole Grain Analyzer-IM 9500.

SDS Sedimentation value (ml): The SDS sedimentation values (ml) of all the wheat samples were determined by near-infrared transmission (NIT) on whole kernels using the Perten Whole Grain Analyzer-IM 9500.

Wet gluten (%): The wet gluten (%) of all the wheat samples were determined by near-infrared transmission (NIT) on whole kernels using the Perten Whole Grain Analyzer-IM 9500.

3.2.3. Statistical data analysis

Analyses of variance were computed using the JMP-07 statistical program (SAS institute, 2005). The analysis of variance was performed to observe the difference among genotypes in their performance in yield and yield related components. Significance levels of these components were determined by using F- test. Means were compared by the Tukey test at 5% probability ($p \leq 0.05$).

4. RESULT AND DISCUSSION

4.1. Days to Heading

Significant variation was identified among the genotypes for days to heading Table 4.1. Cultivars widely varied in days to heading, with 141 and 149 days' differences between the earliest and the latest heading cultivars. The genotype G23 (141.67 days) was among the earliest heading in this season. Days to heading for genotypes are given in Table 4.2 and Figure 4.1. The latest heading cultivar was Ceyhan-99, Cemre (148.67 days) and Pehlivan (147.33 days) which reached 50% heading on 24 April- 2 May in 2016 season. The difference in days to heading between the earliest and latest cultivars was 8-9 days. Environmental effect on the days to heading needed for the occurrence of different growth stages of wheat varied with genotypes (Araus et al. 2007; Rahman et al. 2009). Control of heading time by major and minor genes governing depends on growth habit (Kuspira and Unrau 1957). Besides, Klaimi and Qualset (1974) reported that time to heading had depend on the nature of genes for growth habit and also on other factors affecting this character.

Table 4.1. Analysis of variance (ANOVA) for days to heading in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	298.66667	12.4444	4.5538*
Replication	2	10.16	5.08	1.8589
Error	48	131.17333	2.7328	
C. Total	74	440		
CV %	1.15			

*$p \leq 0.05$

Table 4.2. Means of days to heading for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Days to heading (day)**	
G1	142.67	BC*
G2	144.00	ABC
G3	143.00	BC
G4	142.67	BC
G5 Dinç	144.00	ABC
G6	142.67	BC
G7	144.67	ABC
G8	142.67	BC
G9	142.33	BC
G10 Pehlivan	147.33	AB
G11	142.00	C
G12	143.33	BC
G13	143.67	ABC
G14	144.33	ABC
G15 Cemre	148.67	A
G16	142.33	BC
G17	143.33	BC
G18	145.67	ABC
G19	142.67	BC
G20 Tekin	142.33	BC
G21	146.67	ABC
G22	142.67	BC
G23	141.67	C
G24	146.00	ABC
G25 Ceyhan-99	148.67	A
Average	**144**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

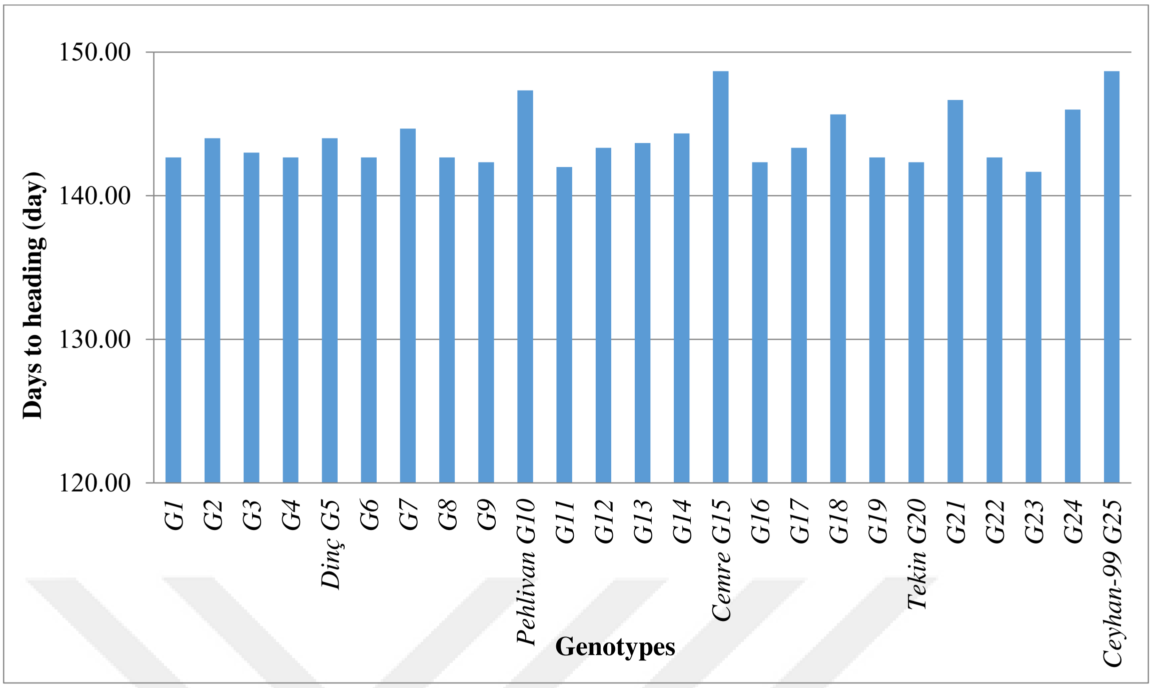

Figure 4.1. Comparison of bread wheat genotypes means for days to heading

4.2. Plant Height (cm)

Plant height (PH) an important character depended on plant architecture and yield potential, is controlled polygenically (Cadalen et al. 1998; Peng et al. 1999; Sakamoto and Matsuoka 2004; Xianshan et al. 2010). Besides, Zhong-hu and Rajaram (1993) reported that yield, kernels per spike, biomass and plant height were more drought sensitive compared with spike number and thousand kernel weight. The analyses of variance showed that plant height was influenced by the wheat variety Table 4.3. The plant height varied among the varieties. Using Tukey's procedure within the tested cultivars two homogeneous groups were identified Table 4.4 and Figure 4.2. For wheat varieties, plant height was the most distinguishable parameter measured; the means are separated into two groups. Cemre (106.67 cm) was the tallest variety of all and G3 (85.33 cm) the shortest. Comparison of wheat genotypes means for plant height is presented in Figure 4.2. These results are in agreement with those of Aktaş et al. (2011) and Kılıç et al. (2012) in the same place.

Table 4.3. Analysis of variance (ANOVA) for plant height in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	1898.4533	79.1022	1.9588*
Replication	2	84.24	42.12	1.043
Error	48	1938.4267	40.3839	
C. Total	74	3921.12		
CV %	6.8			

$^*p \leq 0.05$

Table 4.4. Means of plant height for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Plant height (cm)**	
G1	96.00	AB*
G2	92.33	AB
G3	85.33	B
G4	96.33	AB
G5 Dinç	88.33	AB
G6	91.00	AB
G7	91.33	AB
G8	92.33	AB
G9	88.00	AB
G10 Pehlivan	102.00	AB
G11	93.33	AB
G12	89.33	AB
G13	94.33	AB
G14	92.33	AB
G15 Cemre	106.67	A
G16	98.00	AB
G17	86.33	B
G18	89.67	AB
G19	90.00	AB
G20 Tekin	103.00	AB
G21	90.00	AB
G22	93.00	AB
G23	91.33	AB
G24	95.33	AB
G25 Ceyhan-99	96.33	AB
Average	**93.28**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

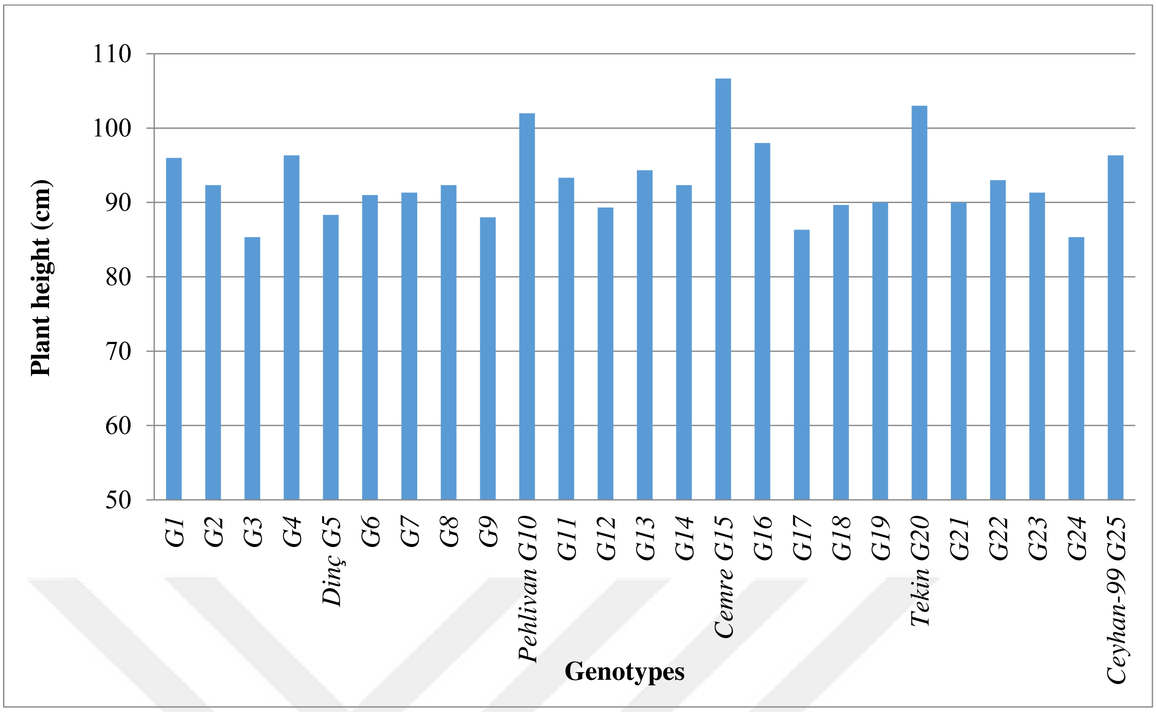

Figure 4.2. Comparison of bread wheat genotypes means for plant height

4.3. Chlorophyll Content (SPAD)

The analysis of SPAD is presented in Table 4.5. Analysis of variance revealed significant differences (P<0.001) among genotypes. Variation of SPAD among 25 genotypes ranged from 45.43 (Cemre) to 52.83 (G7). The maximum means SPAD reading of the 25 genotypes were 52.83, 51.13 and 51.0 for G7, G18 and G8, respectively Table 4.6 and Figure 4.3. Therefore, our study suggests that the GS61 (Zadoks) stage during grain filling may be the optimal time for flag leaf SPAD reading. Similar results were reported by Ommen et al. (1999) and Yıldırım et al. (2011) that the maximum chlorophyll content of flag leaf reached at anthesis under optimum growth conditions in spring wheat. On the other hand, results from the study of Li et al. (2012) suggest that kernels milky ripe stage may be the optimum time for evaluating SPAD of flag leaf chlorophyll content.

Table 4.5. Analysis of variance (ANOVA) for chlorophyll content in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Squares**	**F Ratio**
Genotype	24	241.66	10.0692	3.2794*
Replication	2	32.4992	16.2496	5.2923
Error	48	147.3808	3.0704	
C. Total	74	421.54		
CV %	3.6			

*$p \leq 0.05$

Table 4.6. Means of chlorophyll content for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Chlorophyll Content (SPAD)**	
G1	47.00	BCD*
G2	49.63	A-D
G3	48.90	A-D
G4	47.63	A-D
G5 Dinç	45.47	CD
G6	47.80	A-D
G7	52.83	A
G8	51.00	ABC
G9	50.03	A-D
G10 Pehlivan	50.07	A-D
G11	47.53	A-D
G12	47.77	A-D
G13	49.13	A-D
G14	48.60	A-D
G15 Cemre	45.43	D
G16	49.60	A-D
G17	47.37	A-D
G18	51.13	AB
G19	47.83	A-D
G20 Tekin	45.83	BCD
G21	47.20	BCD
G22	46.77	BCD
G23	48.17	A-D
G24	47.83	A-D
G25 Ceyhan-99	46.43	BCD
Average	**48.28**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

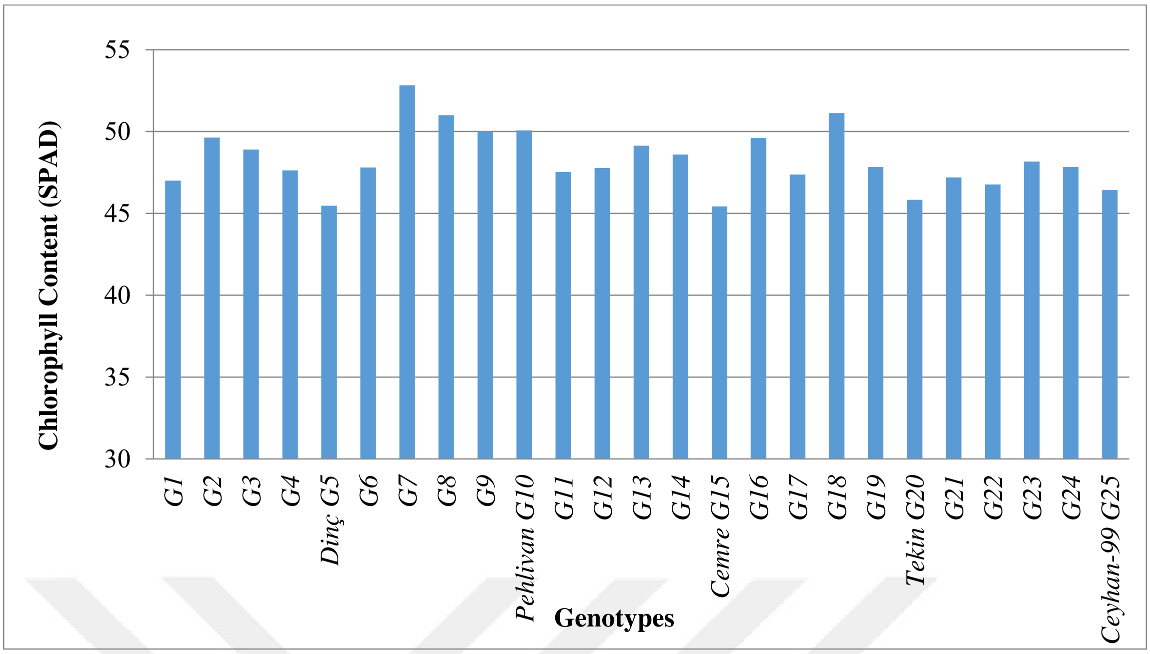

Figure 4.3. Comparison of wheat genotypes means for chlorophyll content

4.4. Peduncle Length (cm)

According to Börner et al. (2002), peduncle length is important in disease escape and breeding for resistance to head diseases, since, plants with shorter peduncles are more susceptible. Analysis of variance Table 4.7 showed significant results for peduncle length. Table means Table 4.8 and Figure 4.4 revealed that the length of peduncle of genotype Tekin (17.67 cm) was largest among the tested genotype followed by Cemre (16.07 cm) G7 (16.00 cm) and the smallest peduncle length was observed for G3 (8.53 cm). In most of the diallel studies of wheat, plant height, spike length and peduncle length seemed to be controlled by the partial dominance with additive gene effects (Chaudhry et al. 2001; Khan and Habib 2003; Riaz and Chowdhry 2003). Amiri et al. (2013) reported that terminal drought stress reduced grain yield, plant height, peduncle length, ratio of peduncle length to plant height, spike length and awn length as much as 23.48%, 1.23%, 2.17%, 0.97%, 2.58% and 2.55%, respectively.

Table 4.7. Analysis of variance (ANOVA) for peduncle length in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	275.01013	11.4588	2.7641*
Replication	2	30.42667	15.2133	3.6698
Error	48	198.98667	4.1456	
C. Total	74	504.42347		
CV %	15.3			

*$p \leq 0.05$

Table 4.8. Means of peduncle length for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Peduncle Lenght (cm)**	
G1	12.73	ABC*
G2	11.20	BC
G3	8.53	C
G4	16.00	AB
G5 Dinç	13.27	ABC
G6	12.53	ABC
G7	16.00	AB
G8	13.93	ABC
G9	11.60	ABC
G10 Pehlivan	11.60	ABC
G11	13.87	ABC
G12	10.93	BC
G13	13.07	ABC
G14	13.00	ABC
G15 Cemre	16.07	AB
G16	13.67	ABC
G17	12.40	ABC
G18	14.80	ABC
G19	12.67	ABC
G20 Tekin	17.67	A
G21	12.93	ABC
G22	15.67	AB
G23	13.13	ABC
G24	12.93	ABC
G25 Ceyhan-99	12.53	ABC
Average	**13.31**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

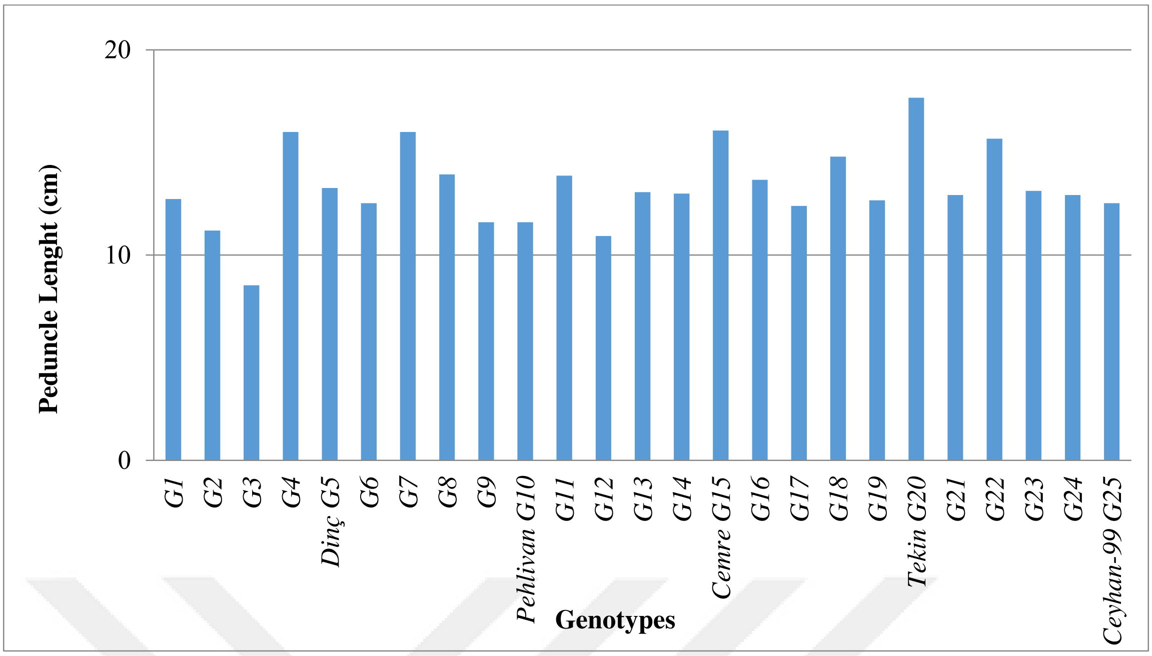

Figure 4.4. Comparison of wheat genotypes means for peduncle length

4.5. Number of Spikes per Square Meter

Hamid and Grafius (1978); Garcia del Moral et al. (1991) have reported that the grain yield in wheat can be analyzed in terms of three yield components number of spikes per square meter, number of grains per spike, and grain weight that seem successively with later-developing components under control of earlier-developing ones. The data analysis show that the (25) bread wheat genotypes had non-significant differences in spikes per square meter. Spikes per square meter ranged from 397.5 to 652.5 m^{-2}. As regards number of spikes per square meter, highest value (652.5 m^{-2}) was recorded in G13, while the lowest grain yield was obtained from G7 (397.5 m^{-2}). (Table 4.10 and Figure 4.5). The results from the present study are in general not agreement with those obtained by Aktaş (2010); Sakin et al. (2015). However, the results from the present study are in partial agreement with those obtained by Nazar (2012).

Table 4.9. Analysis of variance (ANOVA) for number of spikes per square meter in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	225675	9403.13	1.4573 ns
Replication	2	9377.17	4688.58	0.7266
Error	48	309727	6452.65	
C. Total	74	544779.17		
CV %	14			

ns= Non-significant

Table 4.10. Means of number of spikes per square meter for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Number of Spikes per Square Meter**
G1	568.33
G2	600.00
G3	599.17
G4	578.33
G5 Dinç	627.50
G6	577.50
G7	397.50
G8	518.33
G9	494.17
G10 Pehlivan	630.83
G11	580.83
G12	604.17
G13	652.50
G14	586.67
G15 Cemre	529.17
G16	598.33
G17	475.00
G18	598.33
G19	591.67
G20 Tekin	551.67
G21	579.17
G22	583.33
G23	605.83
G24	605.83
G25 Ceyhan-99	636.67
Average	**574.83**

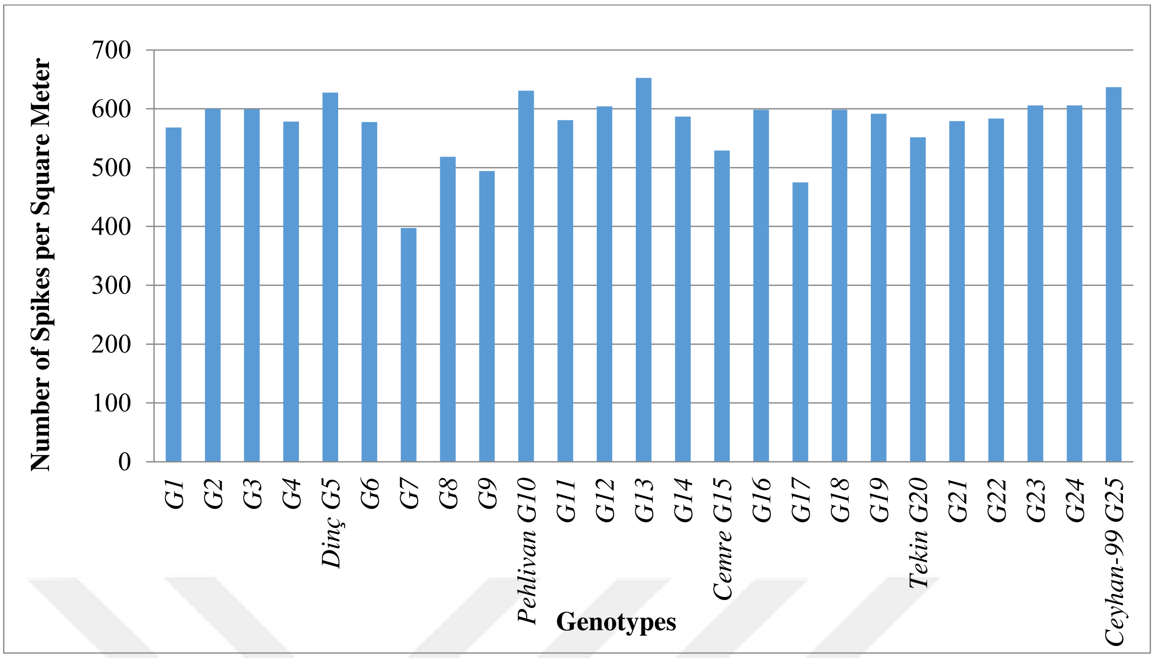

Figure 4.5. Comparison of wheat genotypes means for number of spikes per square meter

4.6. Spike Length (cm)

The investigation of variability and components of phenotypic variance for spike length is very important for improving genotypes in breeding programs (Knežević et al. 2013). Spike length is quantitative trait and it is in relation with other yield components (Zečević et al. 2004; Madić et al. 2006), and wider knowledge about the influence of genetic and environmental variability will contribute to successfulness of breeding programs (Knežević et al. 2013). Analyzed bread wheat genotypes expressed differences ($P<0.01$) in spike length Table 4.11. The research has been recorded higher spike length (12.57 cm) by G7, (12.03 cm) by G9 and (11.77 cm) by G2, while the lowest spike length has been obtained from G19 (10.00 cm). Table 4.12 and Figure 4.6. It means that wheat spike length is highly depended on genetic and environmental factors (Knežević et al. 2013). Our results are higher than those of values obtained by Kara et al. (2016) who stated that the spike length of Turkish spring wheat cultivars ranged from 7.93 cm to 9.32 cm and Gençtan and Balkan (2006) who stated that the moisture content of bread wheat cultivars ranged from 6.92 cm to 7.8 cm.

Table 4.11. Analysis of variance (ANOVA) for spike length in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	30.2	1.25833	4.3877*
Replication	2	1.5144	0.7572	2.6403
Error	48	13.7656	0.28678	
C. Total	74	45.48		
CV %	4.8			

*$p \leq 0.05$

Table 4.12. Means of spike length for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Spike Length (cm)**	
G1	10.87	BCD*
G2	11.77	ABC
G3	10.37	BCD
G4	11.10	A-D
G5 Dinç	10.33	CD
G6	11.43	A-D
G7	12.57	A
G8	10.67	BCD
G9	12.03	AB
G10 Pehlivan	10.97	A-D
G11	11.63	A-D
G12	10.00	D
G13	11.37	A-D
G14	11.37	A-D
G15 Cemre	11.37	A-D
G16	11.63	A-D
G17	10.57	BCD
G18	11.37	A-D
G19	10.00	D
G20 Tekin	11.43	A-D
G21	11.47	A-D
G22	11.10	A-D
G23	11.00	A-D
G24	10.40	BCD
G25 Ceyhan-99	10.20	CD
Average	**11.08**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

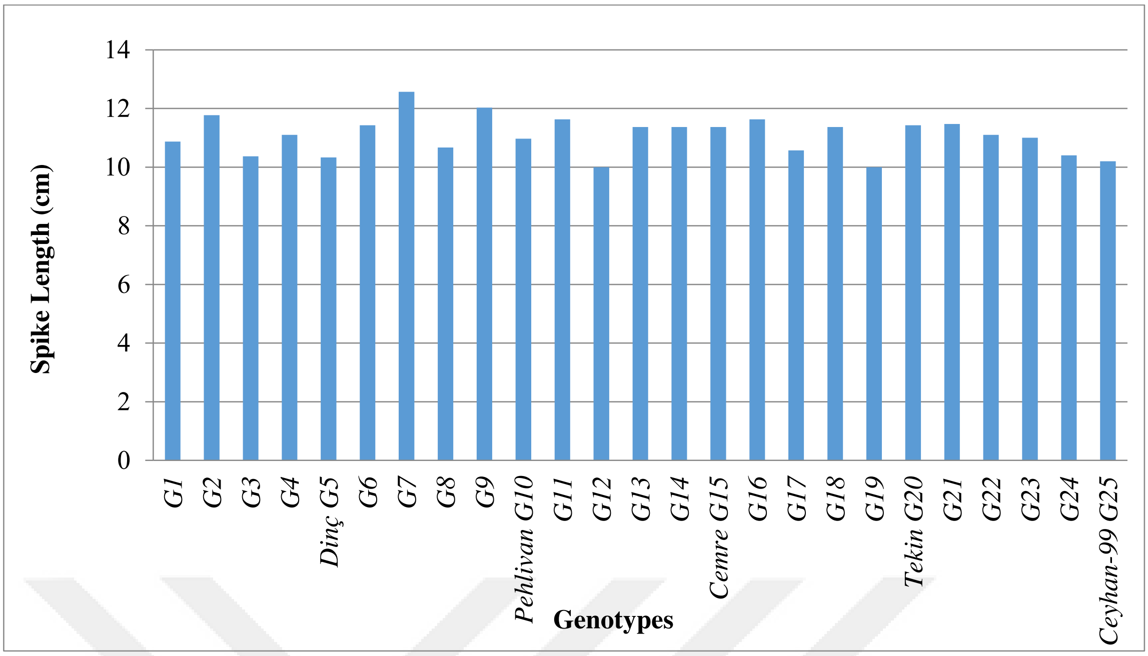

Figure 4.6. Comparison of wheat genotypes means for spike length

4.7. Number of Spikelet per Spike

The searching of variability and components of phenotypic variance for number of spikelet per spike is very important for the wheat breeding programs. Analysis of variance showed significant ($P \leq 0.05$) differences among the tested genotypes for number of spikelet per spike Table 4.13. The research has been recorded higher number spikelet per spike from Pehlivan (20.20) followed by G2 (19.83) and G18 (19.27), while the lowest number of spikelet per spike has been obtained from G3 (17.37) (Table 4.14 and Figure 4.7). The obtained different values and large number of spikelet per spike could be explained primarily optimal conditions for the development of a large number of spikelet per spike. Because, favorable conditions for flowering and pollination, resulting in higher average values for the number of grains per spike (Knezevic et al. 2012). These findings are in agreement with previous study (Dokuyucu et al. 2002; Inceköse 2007; Knezevic et al. 2012).

Table 4.13. Analysis of variance (ANOVA) for number of spikelet per spike in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	29.126667	1.21361	2.2402*
Replication	2	0.5096	0.2548	0.4703
Error	48	26.003733	0.54174	
C. Total	74	55.64		
CV %	3.9			

*p ≤ 0.05

Table 4.14. Means of number of spikelet per spike for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Number of Spikelet per Spike**	
G1	18.97	AB*
G2	19.83	A
G3	17.37	B
G4	18.20	AB
G5 Dinç	19.10	AB
G6	18.20	AB
G7	19.07	AB
G8	18.70	AB
G9	18.93	AB
G10 Pehlivan	20.20	A
G11	18.47	AB
G12	18.87	AB
G13	18.60	AB
G14	18.20	AB
G15 Cemre	18.40	AB
G16	19.00	AB
G17	18.43	AB
G18	19.27	AB
G19	17.40	B
G20 Tekin	18.17	AB
G21	18.77	AB
G22	18.80	AB
G23	18.07	AB
G24	19.03	AB
G25 Ceyhan-99	18.97	AB
Average	**18.68**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

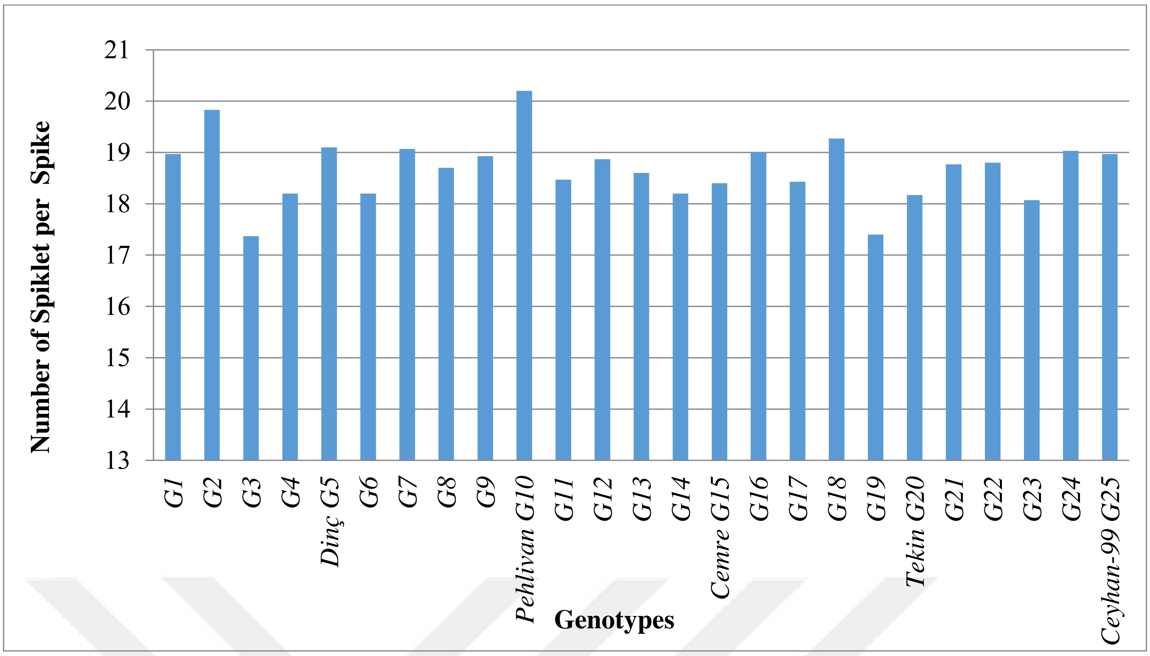

Figure 4.7. Comparison of wheat genotypes means for number of spikelet per spike

4.8. Number of Grains per Spike

Grain number per spike is one of the important yield components, which directly affect genetic yield potential (Zecevic et al. 2010). The analysis of variance showed significant ($P \leq 0.05$) differences among genotypes for number of grains per spike. The analysis of variance for number of grains per spike is showed in Table 4.15. According to the results, the highest number of grains per spike was observed (62.37) by G7 followed by G16 (62.13) and G17 (60.83), while the lowest number of grains per spike was recorded from Pehlivan variety (41.67) (Table 4.16 and Figure 4.8). Similar results for variability of number of grains per spike in study of another wheat genotypes established (Yıldırım et al. 2005). These values variability of kernel number per spike are consistent with studies of Sakin et al. (2015) and Kara et al. (2016).

Table 4.15. Analysis of variance (ANOVA) for number of grains per spike in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	1595.0128	66.459	2.0744*
Replication	2	632.7608	316.38	9.8751*
Error	48	1537.8392	32.038	
C. Total	74	3765.6128		
CV %	10.5			

*$p \leq 0.05$

Table 4.16. Means of number of grains per spike for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Number of Grains per Spike**	
G1	53.77	AB*
G2	55.87	AB
G3	54.00	AB
G4	52.63	AB
G5 Dinç	59.43	AB
G6	50.00	AB
G7	62.37	A
G8	52.60	AB
G9	55.33	AB
G10 Pehlivan	41.67	B
G11	58.00	AB
G12	53.77	AB
G13	58.50	AB
G14	55.77	AB
G15 Cemre	47.90	AB
G16	62.13	A
G17	60.83	A
G18	54.17	AB
G19	52.53	AB
G20 Tekin	50.80	AB
G21	48.33	AB
G22	53.67	AB
G23	55.17	AB
G24	52.53	AB
G25 Ceyhan-99	49.83	AB
Average	**54.06**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

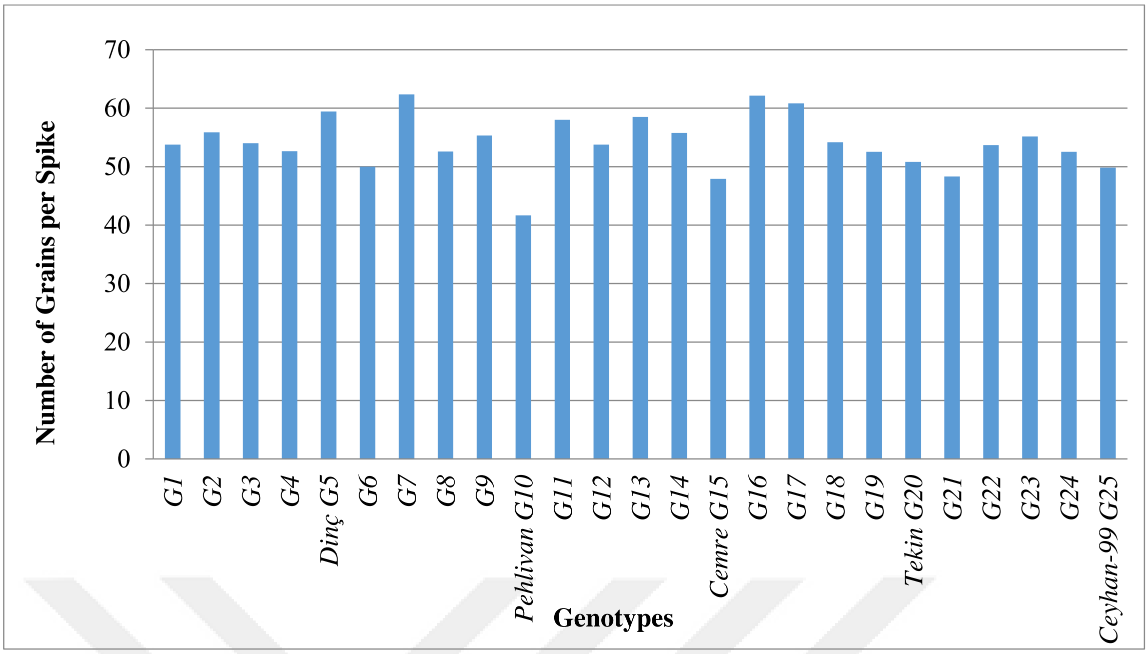

Figure 4.8. Comparison of wheat genotypes means for number of number of grains per spike

4.9. Grains Weight per Spike (g)

High variability and significant difference P≤ 0.05 for grains weight per spike in different genotypes were established by analysis of variance Table 4.17. Grains weight per spike is an important component of yield. A change in grains weight per spike severely influences the final yield. In this study, the highest grains weight per spike was obtained from G7 (1.49 g), G8 (1.44 g) and G16 (1.41 g) respectively, while the lowest grains weight per spike has been obtained from Pehlivan variety was (0.99 g) (Table 4.18 and Figure 4.9). The grains weight per spike is very variable trait, because it depends on grain number and grain chemical composition. This trait is very important yield components, the development of many components that occur in the early ontogenic stages. Grains weight per spike plays a significant role in yield formation, because it directly affects harvest index. Grain weight per plant directly reflects the efficient use of nutrients and their translocation into generative parts of a plant .This yield component is very variable and its look depends highly on the ecological factors (Borojević 1983).

Table 4.17. Analysis of variance (ANOVA) for grains weight per spike in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	1.171221	0.048801	1.8094*
Replication	2	0.016353	0.008177	0.3032
Error	48	1.294598	0.026971	
C. Total	74	2.482172		
CV %	13			

*p ≤ 0.05

Table 4.18. Means of grains weight per spike for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Grains weight per Spike (g)**
G1	1.13
G2	1.35
G3	1.08
G4	1.28
G5 Dinç	1.26
G6	1.34
G7	1.49
G8	1.44
G9	1.33
G10 Pehlivan	0.99
G11	1.33
G12	1.07
G13	1.11
G14	1.13
G15 Cemre	1.18
G16	1.41
G17	1.33
G18	1.36
G19	1.34
G20 Tekin	1.37
G21	1.27
G22	1.23
G23	1.15
G24	1.31
G25 Ceyhan-99	1.17
Average	**1.26**

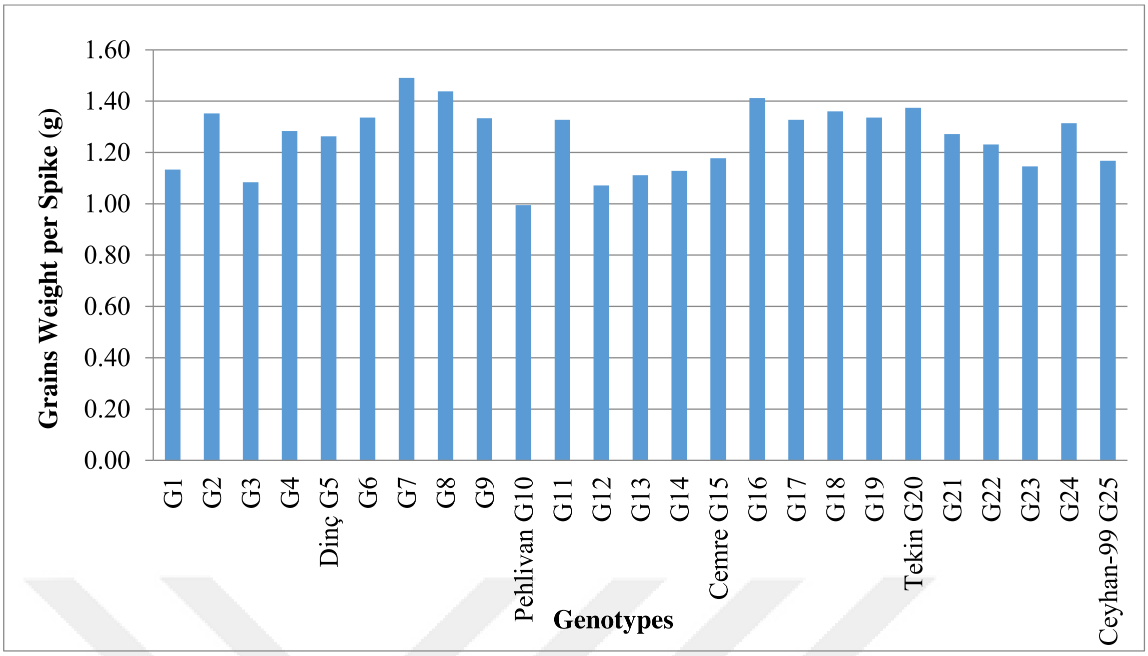

Figure 4.9. Comparison of wheat genotypes means for grains weight per spike

4.10. Grain Yield (kg/ha^{-1})

Grain yield is one of the key economic factor behind a positive wheat (*Triticum aestivum* L.) cropping enterprise and is therefore a major target for wheat breeding programs (Wu et al. 2012). The desired wheat (*Triticum aestivum* L.) genotype should be high yielding under any environmental conditions. But as genetic effects are not independent of environmental effects, most genotypes do not perform satisfactorily in all environments (Carvalho et al. 1983). The analysis of variance for main effect exposed highly significant differences among the genotypes was showed in Table 4.19. As regards grain yield, highest value (8390.0 kg/ha^{-1}) was recorded in G6 wheat followed by G16 (8175.0 kg/ha^{-1}) and G18 (8098.3 kg/ha^{-1}), while the lowest grain yield was obtained from G12 (5840.6 kg/ha^{-1}) (Table 4.20 and Figure 4.10). It is an important factor in obtaining a high yield due to heavy clay and fertile soil of the experiment field. Similar results were obtained by Doğan and Kendal (2012), Kılıç (2012) and Kendal et al. (2013) in same region.

Table 4.19. Analysis of variance (ANOVA) for grain yield in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	40079782	1669991	3.7818**
Replication	2	1680714	840357	1.903
Error	48	21196216	441588	
C. Total	74	62956711		
CV %	9.3			

**p ≤ 0.01

Table 4.20. Means of grain yield for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Grain Yield (kg/ha^{-1})**	
G1	6365.00	ABC*
G2	8067.78	AB
G3	6493.89	ABC
G4	7245.56	ABC
G5 Dinç	7495.56	ABC
G6	8390.00	A
G7	5923.89	C
G8	7448.33	ABC
G9	6568.33	ABC
G10 Pehlivan	6279.44	BC
G11	7706.11	ABC
G12	5840.56	C
G13	7276.11	ABC
G14	6605.56	ABC
G15 Cemre	6166.67	BC
G16	8175.00	AB
G17	6290.56	ABC
G18	8098.33	AB
G19	7683.89	ABC
G20 Tekin	7517.22	ABC
G21	7308.89	ABC
G22	7163.89	ABC
G23	6753.33	ABC
G24	7830.00	ABC
G25 Ceyhan-99	7424.44	ABC
Average	**7124.732**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

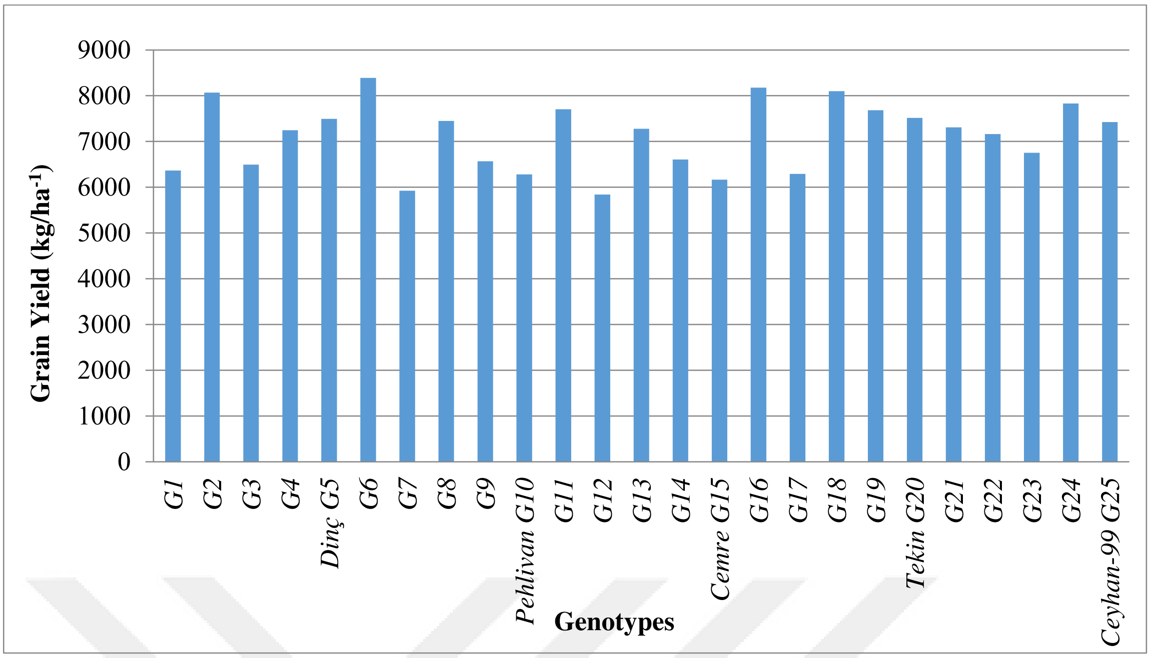

Figure 4.10. Comparison of wheat genotypes means for grain yield

4.11. Moisture Content (%)

Moisture content is one of the most important factors seating the quality of grain during packing, processing and transport. The moisture contents of grains are required this study shows a new method for measuring the moisture contents by using Near Infrared Transmittance in the GAP International Agricultural Research and Training Center from Diyarbakir. In our study, Table 4.21 is showing that the genotype is significant difference $P \leq 0.05$. Also, it has been the highest number of moisture obtained from Pehlivan (8.00%) is followed by G13 and G7 (7.87% to 7.87%), while it has been the lowest number of moisture obtained from G9 (7.67%). This variation may be due to the effect of environmental conditions such as terminal heat stress. Moisture content is mostly affected by relative humidity at harvest and during storage (Makawi et al. (2013) Gordon and Cross (1999) reported that the maturity characters changed conspicuously with humidity, and these differences were inconsistent across genotypes. Our results are lower than those of values obtained by Makawi et al. (2013) who stated that the moisture content of Sudanese wheat cultivars ranged from 10.40 to 12.07% and Kahrıman et al. (2011) who stated that the moisture content of Turkish wheat cultivars ranged from 9.5 to 11.8%.

Table 4.21. Analysis of variance (ANOVA) for moisture content in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	0.38666667	0.016111	1.7586*
Replication	2	0.00026667	0.000133	0.0146
Error	48	0.43973333	0.009161	
C. Total	74	0.82666667		
CV %	1.2			

*p ≤ 0.05

Table 4.22. Means of moisture content for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Moisture Content (%)**	
G1	7.70	AB*
G2	7.83	AB
G3	7.73	AB
G4	7.80	AB
G5 Dinç	7.67	B
G6	7.73	AB
G7	7.87	AB
G8	7.77	AB
G9	7.67	B
G10 Pehlivan	8.00	A
G11	7.83	AB
G12	7.80	AB
G13	7.87	AB
G14	7.83	AB
G15 Cemre	7.80	AB
G16	7.83	AB
G17	7.80	AB
G18	7.77	AB
G19	7.70	AB
G20 Tekin	7.80	AB
G21	7.80	AB
G22	7.83	AB
G23	7.70	AB
G24	7.77	AB
G25 Ceyhan-99	7.77	AB
Average	**7.79**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

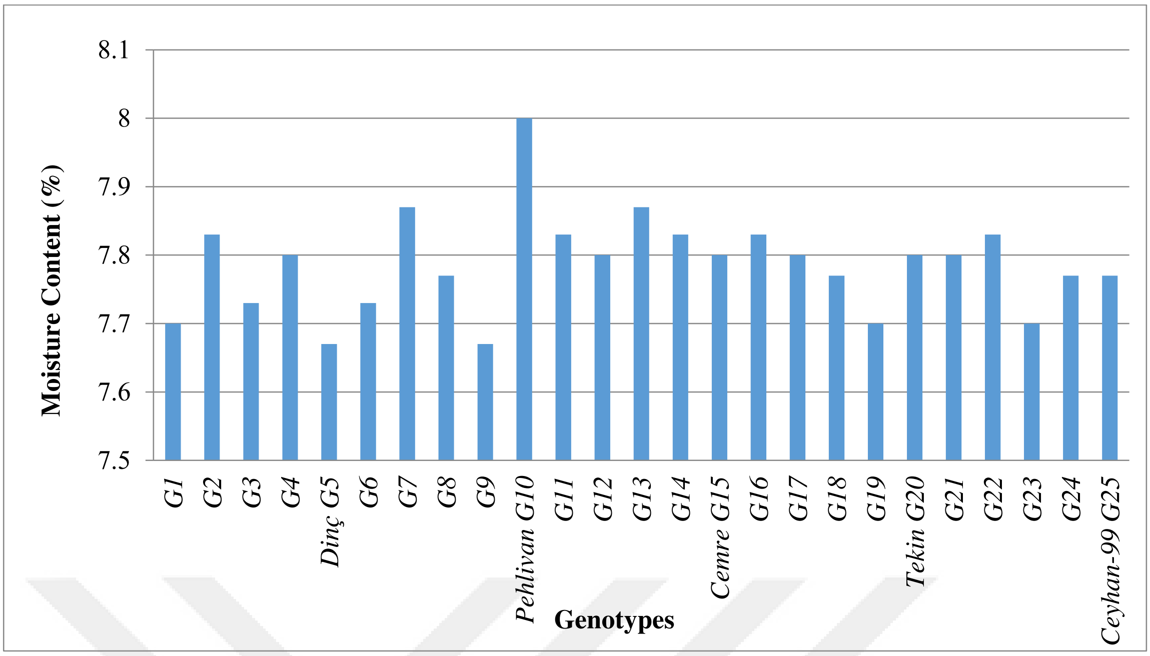

Figure 4.11. Comparison of wheat genotypes means for moisture content

4.12. Thousand Kernel Weight (g)

Thousand kernel weight as well as hectoliter weight is useful index for potential milling yield (Safdar et al. 2009). Highly significant (P<0.01) differences were identified among the genotypes for thousand kernel weight. As regards thousand kernel weight, highest value (42.50 g) was recorded in Pehlivan wheat followed by G8 (39.75 g) and G6 (39.25 g), while the lowest thousand kernel weight was obtained from G13 (29.75 g) (Table 4.24 and Figure 4.12). The differences observed in thousand kernel weight among wheat genotypes may be due to the differences in the genetic make-up of the varieties. Results are comparable with the earlier findings of Aktaş et al. (2011); Kılıç et al. (2012), who reported thousand kernel weight ranges from 22.6-33.9 g; 26.0-33.4 g, respectively, for different wheat varieties grown in Diyarbakir Turkey.

Table 4.23. Analysis of variance (ANOVA) for thousand kernel weight in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	738.36167	30.7651	10.1337**
Replication	2	9.40167	4.7008	1.5484
Error	48	145.72333	3.0359	
C. Total	74	893.48667		
CV %	5			

**p ≤ 0.01

Table 4.24. Means of thousand kernel weight for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Thousand Kernel Weight (g)**	
G1	36.17	B-E*
G2	33.92	C-G
G3	34.83	B-G
G4	34.42	B-G
G5 Dinç	29.92	G
G6	39.25	ABC
G7	38.67	A-D
G8	39.75	AB
G9	32.00	EFG
G10 Pehlivan	42.50	A
G11	35.83	B-F
G12	30.00	G
G13	29.75	G
G14	33.17	D-G
G15 Cemre	37.25	A-E
G16	35.00	B-G
G17	35.17	B-G
G18	34.92	B-G
G19	33.92	C-G
G20 Tekin	33.08	EFG
G21	32.83	EFG
G22	36.17	B-E
G23	30.42	FG
G24	33.50	D-G
G25 Ceyhan-99	32.50	EFG
Average	**34.60**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

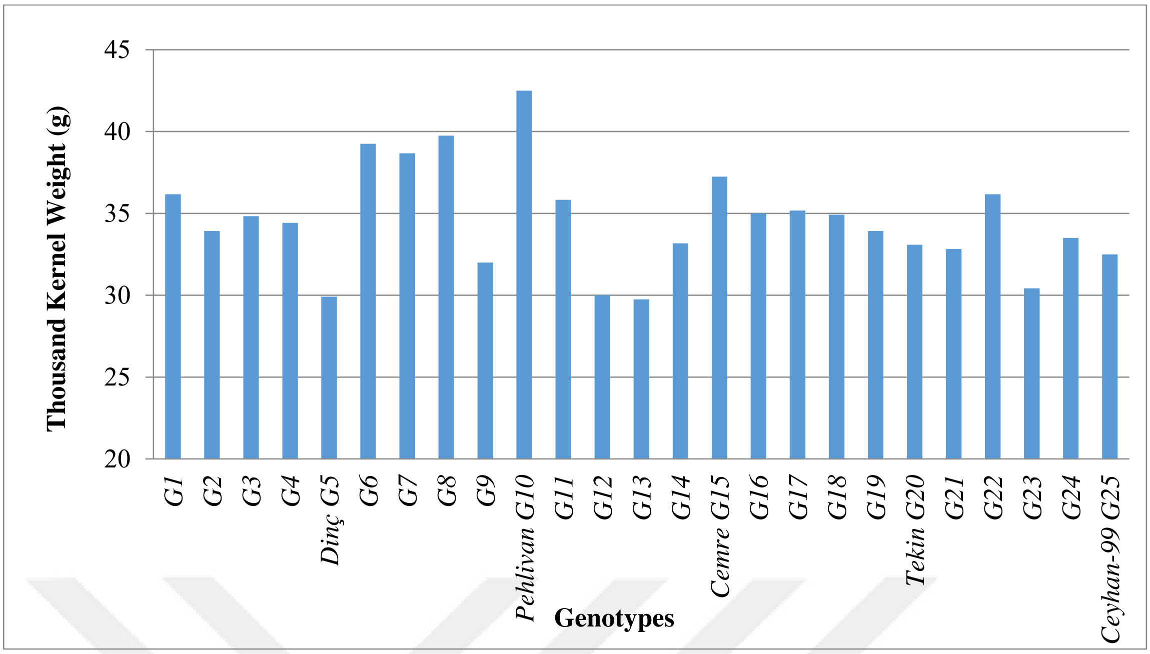

Figure 4.12. Comparison of wheat genotypes means for thousand kernel weight

4.13. Hectoliter Weight (kg/hl^{-1})

The test weight of wheat grain depends on the grain size, shape and density (Protic et al. 2007). The analysis of variance of the hectoliter weight is showing in Table 4.25. Highly significant ($P<0.00$) differences were identified among the genotypes for hectoliter weight. The highest hectoliter weight (kg/hl^{-1}) was recorded (84.73 kg/hl^{-1}) from G11 followed by G14 (83.90 kg/hl^{-1}) and Tekin (83.83 kg/hl^{-1}) respectively, while the lowest hectoliter weight was recorded (79.33 kg/hl^{-1}) from G3 (Table 4.26 and Figure 4.13). Based on results of studies on different genotypes of spring wheat carried out by Aktaş et al. (2011); Kılıç et al. (2012), hectoliter weight ranged from 75.4 to 80 kg/hl^{-1}.

Table 4.25. Analysis of variance (ANOVA) for hectoliter weight in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	149.09813	6.21242	11.4387**
Replication	2	0.58427	0.29213	0.5379
Error	48	26.06907	0.54311	
C. Total	74	175.75147		
CV %	0.9			

**p ≤ 0.01

Table 4.26. Means of hectoliter weight for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Hectoliter Weight (kg/hl^{-1})**	
G1	81.63	B-J*
G2	81.63	B-J
G3	79.33	J
G4	81.23	C-J
G5 Dinç	82.40	A-G
G6	81.97	B-I
G7	82.50	A-G
G8	80.40	F-J
G9	81.13	D-J
G10 Pehlivan	83.07	A-E
G11	84.73	A
G12	82.00	B-I
G13	79.80	IJ
G14	83.90	AB
G15 Cemre	81.37	C-J
G16	80.00	HIJ
G17	83.53	ABC
G18	80.17	G-J
G19	83.03	A-E
G20 Tekin	83.83	AB
G21	83.37	A-D
G22	82.57	A-F
G23	83.73	AB
G24	80.93	E-J
G25 Ceyhan-99	82.30	B-H
Average	**82.02**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

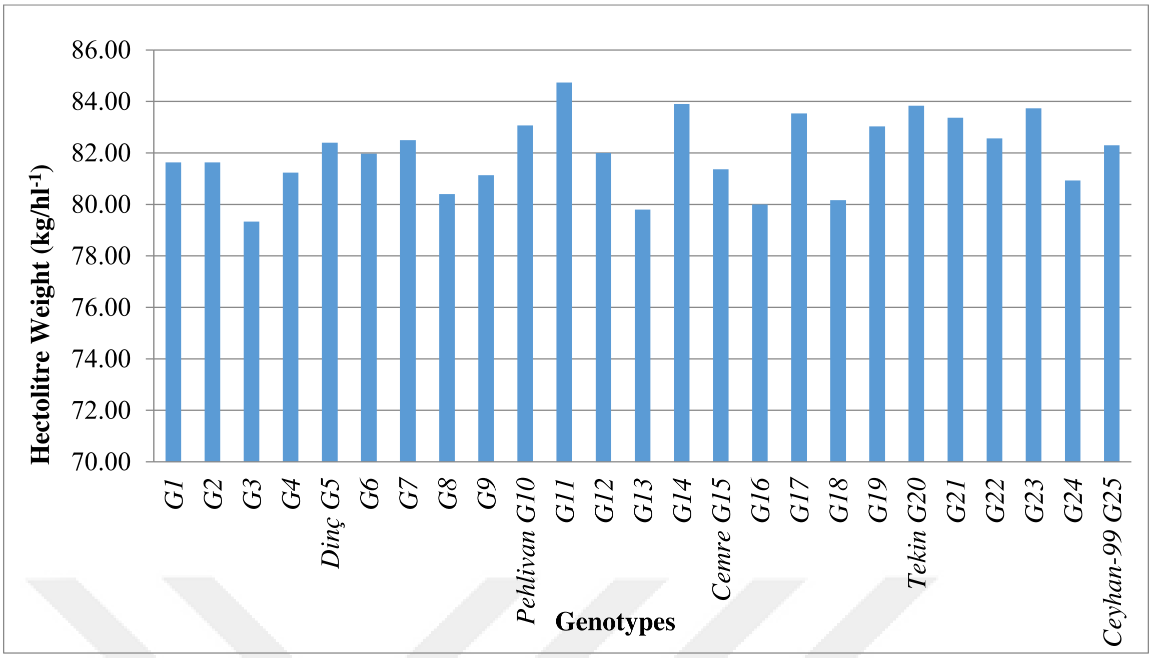

Figure 4.13. Comparison of wheat genotypes means for hectoliter weight

4.14. Protein Content (%)

It is therefore essential that durum wheat cultivars with high protein content and g-gliadin 45 be used for pasta products with high cooking quality (Sakin et al. 2011). Significant differences (P<0.05) in the mean of protein content were observed among bread wheat genotypes (Table 4.27, Table 4.28 and figure 4.14). The genotypes with the highest protein content were G1 (15.33%), G3 (15.27%) and Pehlivan (15.07%) respectively. The genotypes with the lowest protein content was G12 (13.17%). However, low variation for this trait was observed among genotypes. These results are in agreement with the results on bread wheat reported by Menderes et al. (2008); Sakin et al. (2011); Aktaş et al. (2011) and Kılıç et al. (2012).

Table 4.27. Analysis of variance (ANOVA) for protein content in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	21.5152	0.896467	1.797*
Replication	2	0.221067	0.110533	0.2216
Error	48	23.9456	0.498867	
C. Total	74	45.681867		
CV %	5			

*p ≤ 0.05

Table 4.28. Means of protein content for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Protein Content (%)**
G1	15.33
G2	14.17
G3	15.27
G4	13.93
G5 Dinç	13.80
G6	13.97
G7	14.03
G8	14.37
G9	14.17
G10 Pehlivan	15.07
G11	14.00
G12	13.17
G13	14.20
G14	13.87
G15 Cemre	14.83
G16	14.13
G17	14.00
G18	14.70
G19	13.20
G20 Tekin	13.50
G21	14.43
G22	14.17
G23	14.30
G24	13.90
G25 Ceyhan-99	13.87
Average	**14.18**

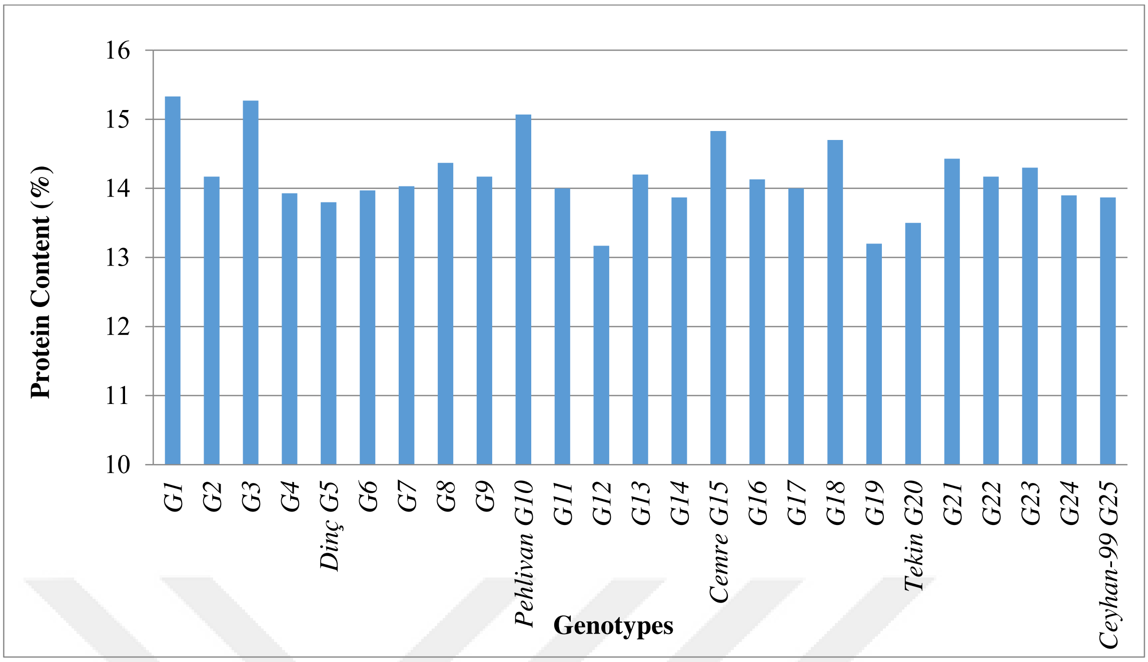

Figure 4.14. Comparison of wheat genotypes means for protein content

4.15. SDS Sedimentation Value (ml)

The sedimentation value (SV) assessment provides information on the protein quantity and the quality of wheat flour (Makawi et al. 2013). The analysis of variance of the SDS sedimentation value is showing that in Table 4.29. Significant ($P \leq 0.05$) differences were identified among the genotypes for SDS sedimentation value. The highest SDS sedimentation value (ml) has been recorded from G3 (60.67 ml) followed by G1 (59.33 ml) and Pehlivan (54.33 ml) respectively, while the lowest SDS sedimentation value was recorded from G12 (44.00 ml) (Table 4.30 and Figure 4.15). Similarly, Kılıç et al. (2012) stated that the sedimentation value of the twenty five Turkish cultivars and advanced lines (Basribey-94, Kaşifbey-95, Pamukova-97, Tahirova-2000, Adana-99, Sakin and Nurkent) Makawi between 18.0-39.0 ml. in some region. Additionally, Kaya and Akcura (2014) found the SDS value of 24–33 ml for Turkish wheat genotypes grown in different environments.

Table 4.29. Analysis of variance (ANOVA) for SDS sedimentation value in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	1282.8533	53.4522	1.8946*
Replication	2	14.48	7.24	0.2566
Error	48	1354.1867	28.2122	
C. Total	74	2651.52		
CV %	10.6			

*$p \leq 0.05$

Table 4.30. Means of SDS sedimentation value for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**SDS sedimentation value**
G1	59.33
G2	49.67
G3	60.67
G4	50.00
G5 Dinç	47.00
G6	49.00
G7	49.67
G8	53.00
G9	51.33
G10 Pehlivan	54.33
G11	48.00
G12	44.00
G13	51.67
G14	47.67
G15 Cemre	53.33
G16	51.33
G17	47.67
G18	47.00
G19	45.00
G20 Tekin	45.67
G21	51.00
G22	48.67
G23	53.33
G24	45.33
G25 Ceyhan-99	44.33
Average	**49.92**

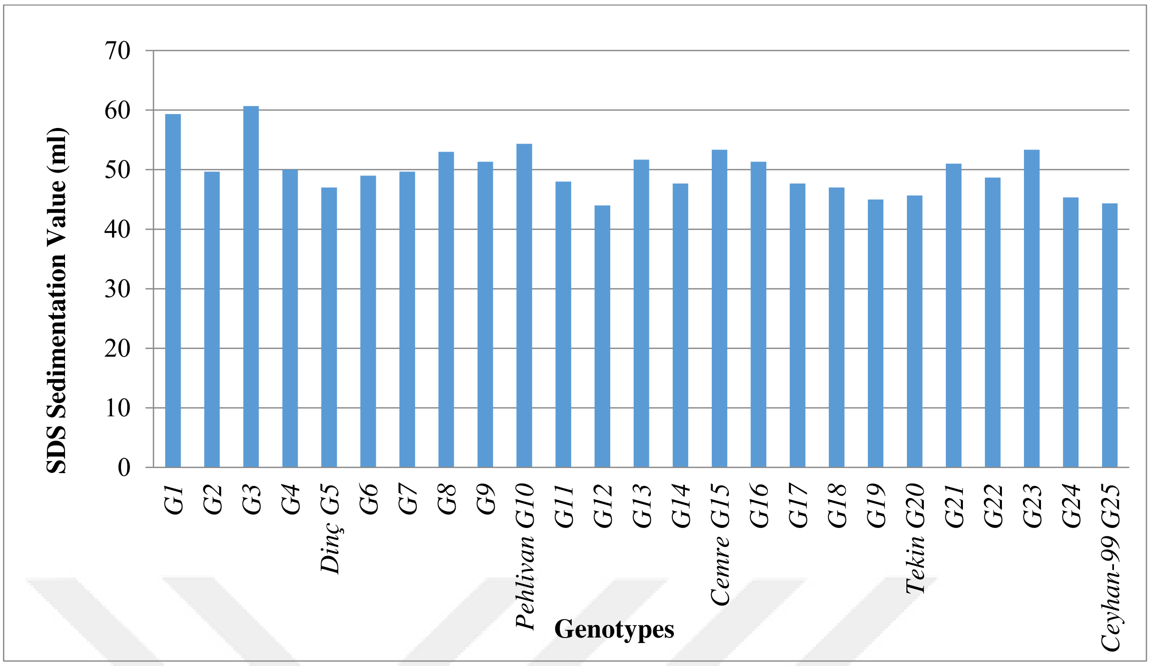

Figure 4.15. Comparison of wheat genotypes means for SDS sedimentation value

4.16. Wet Gluten (%)

Among the wheat quality components, gluten plays the most important role in determining industrial use, and therefore gluten strength is one of the parameters for classification of wheat for use in bread, cakes, and pasta (Pomeranz 1988; Módenes et al. 2009). Significant differences ($P \leq 0.05$) in the mean of wet gluten were observed among bread wheat genotypes. The results of the mean of wet gluten are presented in Table 4.31, Table 4.32 and figure 4.16. As shown in Table 4.32, the wet gluten of bread wheat varieties are ranged between 32.23% (G1) and 27.30% (G12), with an average value of 29.52%. Similar results for investigation of genotypes for wet gluten traits recognized by several writers (Menderes et al. 2008; Cristina et al. 2014; Sakin et al. 2011).

Table 4.31. Analysis of variance (ANOVA) for wet gluten in 25 bread wheat genotypes

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Genotype	24	105.21147	4.38381	2.0003*
Replication	2	1.34427	0.67213	0.3067
Error	48	105.19573	2.19158	
C. Total	74	211.75147		
CV %	5			

*$p \leq 0.05$

Table 4.32. Means of wet gluten for 25 bread wheat genotypes grown in Diyarbakir at 2015/2016

Genotypes	**Wet Gluten (%)**	
G1	32.23	A*
G2	29.60	ABC
G3	32.07	AB
G4	29.00	ABC
G5 Dinç	28.70	ABC
G6	29.17	ABC
G7	29.23	ABC
G8	30.00	ABC
G9	29.50	ABC
G10 Pehlivan	31.60	ABC
G11	29.13	ABC
G12	27.30	C
G13	29.60	ABC
G14	28.87	ABC
G15 Cemre	31.10	ABC
G16	29.47	ABC
G17	29.23	ABC
G18	29.30	ABC
G19	27.47	BC
G20 Tekin	28.10	ABC
G21	30.10	ABC
G22	29.50	ABC
G23	29.90	ABC
G24	29.00	ABC
G25 Ceyhan-99	28.90	ABC
Average	**29.52**	

*Means followed by the same letter in the column are not statistically different between each other by the Tukey test at 5% probability ($p \leq 0.05$).

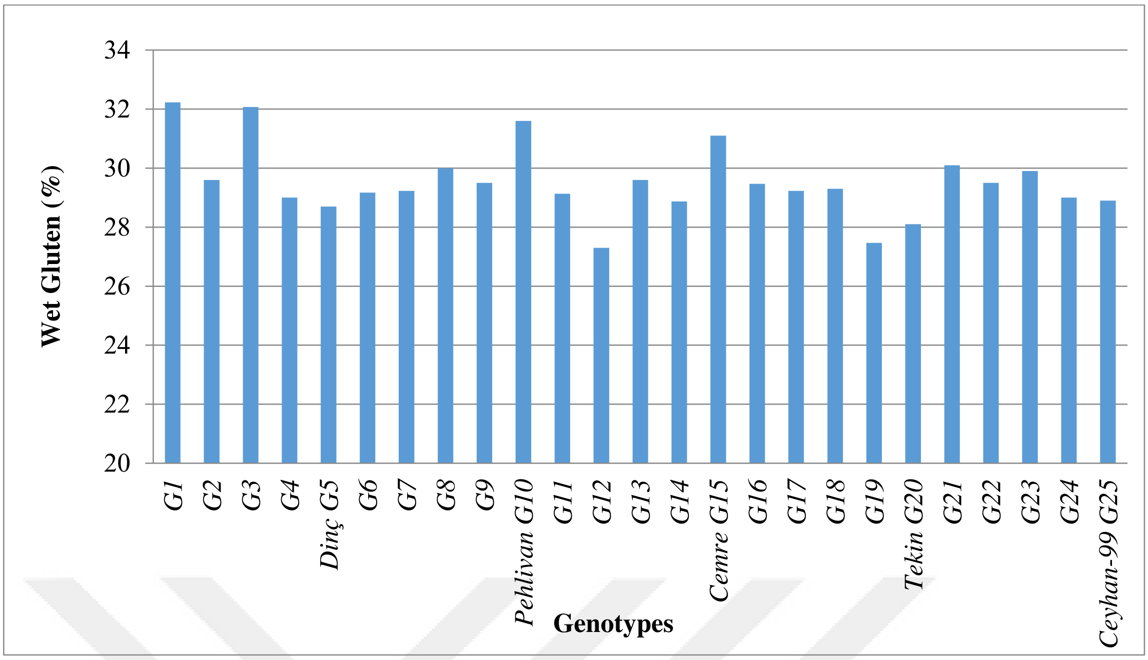

Figure 4.16. Comparison of wheat genotypes means for wet gluten

4.17. Correlation

Grain yield was positively and significantly correlated with plant height (r= 0.3048), number of spikes per square meter (r= 0.4363) and grains weight per spike (r= 0.3587), while it had significantly negative correlations with protein content (r= -0.2808), SDS sedimentation value (r= -0.3728) and wet gluten (r= -0.3575) (Table 4.33). This result is in agreement with the results of Sarkar et al. (1988), Hadjichristodoulou (1989), El-Marakby et al. (1994), Subhani and Khaliq (1994), Mondal et al. (1997), Dokuyucu and Akaya (1999), Mondal and Khajuria (2001). Some authors also reported positive and significant correlations between grain yield and plant height (Subhani and Khaliq 1994; Chaturvedi and Gupta 1995; Khan et al. 1999). Several investigators found spikes per m^2 to be correlated significantly and positively with grain yield (Munir et al. 2007; Akram et al. 2008; Nofouzil et al. 2008).

Days to heading was positively and significantly correlated with plant height (r= 0.2442) and moisture content (r= 0.2529), while it had significantly negative correlations with number of grains per spike (r= -0.2493) (Table 4.33).

Plant height was positively and significantly correlated with days to heading (r= 0.2442), peduncle length (r= 0.4309), number of spikes per square meter (r= 0.4508), grain yield (r= 0.3048) and moisture content (r= 0.2502), while it had significantly negative correlations with chlorophyll content (r= -0.3075) and number of grains per spike (r= -0.2547) (Table 4.33).

Chlorophyll content was positively and significantly correlated with spike length (r= 0.3585), grains weight per spike (r= 0.2748), thousand kernel weight (r= 0.3099), protein content (r= 0.2874) and SDS sedimentation value (r= 0.2575), while it had significantly negative correlations with plant height (r= -0.3075) number of spikes per square meter (r= -0.4488) and hectoliter weight (r= -0.3203) (Table 4.33).

Peduncle length was positively and significantly correlated with plant height (r= 0.4309) grains weight per spike (r= 0.2181), moisture content (r= 0.2501) and hectoliter weight (r=

0.3023), while it had significantly negative correlations with protein content (r= -0.377), SDS sedimentation value (r= -0.3772) and wet gluten (r= -0.3542) (Table 4.33).

Number of spikes per square meter was positively and significantly correlated with plant height (r= 0.4508) and grain yield (r= 0.4363), while it had significantly negative correlations with chlorophyll content (r= -0.4488), spike length (r= -0.2894), grains weight per spike (r= -0.621) and thousand kernel weight (r= -0.2402) (Table 4.33).

Spike length was positively and significantly correlated with chlorophyll content (r= 0.3585) and number of spikelet per spike (r= 0.4191), number of grains of spike (r= 0.342), protein content (r= 0.2777), SDS sedimentation value (r= 0.2761) and wet gluten (r= 0.2688), while it had significantly negative correlations with number of spikes per square meter (r= -0.2894) (Table 4.33).

Number of spikelet per spike was positively and significantly correlated with spike length (r= 0.4191) (Table 4.33).

Number of grains per spike was positively and significantly correlated with spike length (r= 0.342), while it had significantly negative correlations with plant height (r= -0.2547) and days to heading (r= -0.2493) (Table 4.33).

Grains weight per spike was positively and significantly correlated with chlorophyll content (r= 0.2748), peduncle length (r= 0.2181) and grain yield (r= 0.3587), while it had significantly negative correlations with number of spikes per square meter (r= -0.621), SDS sedimentation value (r= -0.2335) and wet gluten (r= -0.2681) (Table 4.33).

Moisture content was positively and significantly correlated with plant height (r= 0.2502), days to heading (r= 0.2529), peduncle length (r= 0.2501) and thousand kernel weight (0.3376) (Table 4.33).

Thousand kernel weight was positively and significantly correlated with chlorophyll content (r= 0.3099) and moisture content (r= 0.3376), while it had significantly negative correlations with number of spikes per square meter (r= -0.2402) (Table 4.33).

Hectoliter weight was positively and significantly correlated with peduncle length (r= 0.3023), while it had significantly negative correlations with chlorophyll content (r= -0.3203), protein content (r= -0.4537), SDS sedimentation value (r= -0.4442) and wet gluten (r= -0.3938) (Table 4.33).

Protein content was positively and significantly correlated with chlorophyll content (r= 0.2874), spike length (r= 0.2777), SDS sedimentation value (r= 0.9081) and wet gluten (r= 0.9577), while it had significantly negative correlations with peduncle length (r= -0.377), grain yield (r= -0.2808) and Hectoliter weight (r= -0.4537) (Table 4.33).

Sedimentation value was positively and significantly correlated with chlorophyll content (r= 0.2575), spike length (r= 0.2761), protein content (r= 0.9081) and wet gluten (r= 0.957), while it had significantly negative correlations with peduncle length (r= -0.3772), grains weight per spike (r= -0.2335), grain yield (r= -0.3728) and hectoliter weight (r= -0.4442) (Table 4.33).

Wet gluten was positively and significantly correlated with spike length (r= 0.2688), protein content (r= 0.9577) and SDS sedimentation value (r= 0.957), while it had significantly negative correlations with peduncle length (r= -0.3542), grains weight per spike (r= -0.2681), grain yield (r= -0.3575) and hectoliter weight (r= -0.3938) (Table 4.33).

Table 4.33. Correlation matrix of morpho-physiological and quality traits under rainfed condition during the growing season since 2015-2016 in Diyarbakir

CHA	PH	DH	CHL	PL	SP/m^2	SPL	SPL/SP	NG/SP	GW/SP	GY	MC	TKW	HL	PC	SDS	WG
PH	1															
DH	0.2442*	1														
CHL	-0.3075**	-0.0928	1													
PL	0.4309**	0.0725	-0.1495	1												
SP/m^2	0.4508**	0.1197	-0.4488**	-0.0193	1											
SPL	0.0769	-0.1095	0.3585**	0.1521	-0.2894*	1										
SPL/SP	0.0645	0.1948	0.216	-0.0828	-0.0127	0.4191**	1									
NG/SP	-0.2547*	-0.2493*	0.1343	0.1174	-0.1399	0.342**	0.0863	1								
GW/SP	-0.1434	-0.1875	0.2748*	0.2181*	-0.621**	0.1995	-0.0215	0.1028	1							
GY	0.3048*	-0.0731	-0.1987	0.198	0.4363**	-0.0447	-0.0366	-0.071	0.3587**	1						
MC	0.2502*	0.2529*	0.0954	0.2501*	0.0251	0.0715	0.1425	-0.134	-0.0328	-0.0607	1					
TKW	0.1925	0.1416	0.3099*	0.167	-0.2402*	0.1399	0.0804	-0.1771	0.1731	-0.0134	0.3376**	1				
HL	0.1492	0.0426	-0.3203**	0.3023*	-0.0232	-0.0337	-0.1194	-0.0659	0.0167	-0.0523	0.2063	0.0935	1			
PC	-0.113	0.0186	0.2874*	-0.377**	-0.1236	0.2777*	0.2204	-0.1387	-0.2174	-0.2808*	-0.1841	0.1576	-0.4537**	1		
SDS	-0.1095	-0.1659	0.2575*	-0.3772**	-0.1687	0.2761*	0.1072	-0.0729	-0.2335*	-0.3728**	-0.1858	0.1059	-0.4442**	0.9081**	1	
WG	-0.0458	0.0218	0.2286	-0.3542**	-0.1415	0.2688*	0.2139	-0.1375	-0.2681*	-0.3575**	-0.1346	0.1931	-0.3938**	0.9577**	0.957**	1

*$p \leq 0.05$; **$p \leq 0.01$, CHA= Characters, PH= Plant height, DH= Days to heading, CHL= Chlorophyll content, PL=Peduncle length, SP/m^2= Number of spikes per square meter, SPL= Spike length, SPL/SP= Number of spikelet per spike, NG/SP= Number of grains per spike, GW/SP= Grains weight per spike, GY= Grain yield, MC= Moisture content, TKW= Thousand kernel weight, HL= Hectoliter weight, SDS= Sedimentation value, WG= Wet gluten.

5. SUMMARY AND CONCLUSION

Wheat (*Triticum aestivum* L.) is a main cereal crop in many parts of the world and it is usually known as the king of cereals. It belongs to *Poaceae* family and globally, after maize and rice, is the most cultivated cereal (Faostat 2013). Wheat, *Triticum aestivum* L. (*Poaceae*) is grown on about 7.92 million hectare, area annually with the production of approximately 15.7 million tons in Turkey (TUIK 2014). Our results was carried out on 20 advanced lines and Dinç, Pehlivan, Cemre, Tekin, Ceyhan-99 as variety bread wheat genotypes in GAP International Agricultural Research and Training Center Diyarbakir, Turkey. The experiment was conducted in a Randomized Block Design with three replications. Plot size was (1.2 × 6 m) 7.2 m^{-2}, the planting depth was 5 cm. The plot size was 6 m length with 6 rows and row spacing was 20 cm. Genotypes were sown at the seed rate of 400 seed m^{-2}, sowing time in the 13 November 2015 and harvested in the 23 June 2016. The plots were fertilized with 60 kg/ha^{-1} N and 60 kg/ha^{-1} P_2O_5 at the planting and 60 kg/ha^{-1} N in spring at stem elongation for drought conditions. Morphological and quality traits were considered: days to heading, plant height, chlorophyll content, peduncle length, number of spikes per square meter, spike length, number of spikelet per spike, number of grains per spike, grains weight per spike, grain yield, moisture content, thousand kernel weight, hectoliter weight, protein content, SDS sedimentation value, and wet gluten. There were significant differences among genotypes for all evaluated characters except the number of spikes per m^{-2}. This study is measured the impacts of 25 bread wheat genotypes improved varieties developed under rain fed condition production in Diyarbakir, Turkey. The objectives of the study were to determine the genotypic variation with agronomic performance with rainfed condition among diverse bread wheat genotypes based on agronomic traits and to identify promising advanced lines for region. The values number of grains per spike extended in this study showed that the differences between the analyzed cultivars, and by experimental investigation. This indicate that genotype have influence to variation of grain yield, highest value (8390.0 kg/ha^{-1}) was recorded in G6 bread wheat followed by G16 (8175.0 kg/ha^{-1}) and G18 (8098.3 kg/ha^{-1}), while the lowest grain yield was obtained from G12 (5840.6 kg/ha^{-1}) was established for the expression grain yield in analyzed wheat genotypes. For improvement of grain yield it is necessary to increase influence of genetic factor for all yield components. The higher impact of genetic factor in expression of grain yield well other yield components. The results also showed that advanced lines G1 and G3 and had the highest values in terms of quality parameters. In terms of grain yield, the variety Tekin and advanced lines G6, G16, and G18 had the highest yield. In this study, except G7, G12 and Cemre that showed relatively worse yield performances, the remaining genotypes showed similarly grain yield in tested environment. This indicated that a need to develop cultivars that have high yield as well as high quality traits across more locations over a season but this experiment evaluated 25 genotypes at one location in a single cropping season. Therefore, to give an acceptable recommendation, the experiment should be repeated in more number of environments.

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I was born in Hajiawa - Sulaimani IRAQ in 1989. I completed primary, secondary and preparatory school education in Hajiawa. I graduated from the Department of Field Crops Faculty of Agriculture Sciences in the University of Sulaimani 2007-2011. I enrolled at the Postgraduate Programme in Bingol University in the Department of Field Crops in February 2015, and completed my research in May 2017.