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Evaluation of growth, yield, quality and physiological parameters of eleven Australian bread wheat (*Triticum aestivum* L.) cultivars grown under the ecological condition of Diyarbakir, Turkey

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Abstract

Wheat cultivars generally show significant differences for grain yield, quality and physiological parameters under different environmental conditions. Thus it is crucial to assess the performance of bread wheat genotypes collected from different origins for domestication for a specific ecologic conditions and also to develop high yield as well as stress tolerant cultivars. In the context, the study was carried out under the ecological condition of Diyarbakır in Turkey during 2014-2015 growing season. In the present research, three Turkish origin bread wheat cultivars such as 'Pehlivan', 'Ceyhan 99' and 'Seri 2013' and eleven bread wheat of Australian origin such as 'LPB 08-1799', 'Eagle Rock', 'Magenta', 'Emu Rock', 'Wyalkatchem', 'Young', 'Calingiri', 'Yitpi', 'Corack', 'Envoy' and 'Mace' were used as experimental plant material. Data on grain yield, grain hardness, plant height, test weight, thousand kernel weight, wet gluten, protein content, zeleny sedimentation, starch content, normalized differences vegetative index, SPAD, leaf area index and canopy temperature were investigated in the study. After evaluation, it was found that all recorded traits of fourteen wheat bread cultivars were changed according to cultivars under the ecological conditions of Diyarbakir-Turkey. However, genotypes which were Australian origin performed the best than Turkish origin. Among the genotypes, the maximum values for grain yield, quality and physiological parameters were recorded for cultivar, 'Mace' (for grain yield) and 'Young' (for quality traits). Therefore, cultivars which were Australian origin can be grown and also may be used in the breeding programs to develop wheat cultivars to cultivate under the Diyarbakir ecological conditions of Turkey.

Keywords: Canopy temperature, Leaf area index, NDVI, Protein content

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Introduction

Bread wheat (*Triticum aestivum* L.) plays a significant role in terms of human nutrition (Hossain et al., 2018). It serves as a staple food for 40 percent of the world's population (Bockus et al., 2010). Wheat is consumed in different forms which includes; leavened breads and rolls, flat breads, porridge, biscuits, cakes, pasta and noodles (Shewry, 2009). It serves as a source of more 20% of the food calories (Bockus et al., 2010), protein, essential amino acids, minerals, vitamins and dietary fiber to the world's diet than any other food crops (Wijngaard and Arendt 2006; Shewry, 2009; Šramková et al., 2009; Kumar et al., 2011; Yildirim et al., 2018) and also provides about 55 percent of the carbohydrates (Breiman and Graur, 1995) globally.

In Turkey, wheat contributes more than half of the calories and protein in the diet. Although, Turkey is the tenth biggest wheat producer in the world with annual production is around 21.5 million tons from a total wheat production area of 7.66 million ha in 2017. The average yield of wheat in Turkey is 2.8 tons ha^{-1} (FAOSTAT, 2017). While its demand is increasing day by day to meet the food demand of the rapidly growing population. Therefore, it should be a continuous process to develop wheat varieties which are suitable to grow under the diverse environmental condition of Turkey. Although wheat has ability to grow multiple environmental conditions across the globe according their species, types as well as adaptability. Wheat plant generally shows differences in growth, grain yield, and quality traits as a result of variation of physiological and biochemical process of the plants under different environmental conditions. Some genotypes adapt easily to changing environment, while others are insufficient to adapt to changing conditions. Therefore, it is important to examine the wheat genotypes developed in different regions in terms of grain yield, quality and physiological parameters under diverse ecological conditions. The purpose of this study was to evaluate of the grain yield, quality and physiological parameters of some bread wheat cultivars which were originated from Australia and Turkey.

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Material and Methods

Plant material, growing conditions and design of field experiment

A field experiment was carried out during November to June, 2014-2015 at the Research Area of the Faculty of Agriculture, Dicle University, Turkey (latitude 37° 53ꞌ 21.50ꞌꞌ N, longitude 40° 16ꞌ 34. 79ꞌꞌ E and 670 m above sea level). In the study, three Turkish origin bread wheat cultivars (i.e. 'Pehlivan', Ceyhan 99, 'Seri 2013') and eleven Australian origin bread wheat (i.e. 'LPB 08-1799', 'Eagle Rock', 'Magenta', 'Emu Rock', 'Wyalkatchem', 'Young', 'Calingiri', Yitpi', 'Corack', 'Envoy' and 'Mace') were used as plant material. Monthly mean temperatures and precipitation are showed in Figure 1.

The study was established randomized complete block design with four replications. All the cultivars were grown in 4 m long 6 rows with a 20 cm row spacing. The plant was fertilized with 60 kg N and P_2O_5 ha^{-1} (20:20:0 NPK) at sowing and 60 kg N ha^{-1} (33 % ammonium nitrate) at tillering stage. The plants were harvested at full maturity by Hege-125 trial harvester machine in June.

Data collection and their procedure

Grain yield: Plot weight was calculated in kg plot^{-1} and then converted to kg ha^{-1}

1000-kernel weight (TKW): In order to determine TKW, four hundred grains was counted with seed counter, which were then weighed (g) and the result multiplied by 2.5.

Plant height: Plant height was measured on ten randomly selected from the base of plant to the tip of the spike, by using a measuring tape.

Test weight, grain hardness, starch content, protein content, zeleny sedimentation and wet gluten: Grain samples were measured without subjected to milling process with NIT System Infratec 1241 Grain Analyzer (Foss).

Chlorophyll reading (SPAD): At the heading stage of plant, the chlorophyll content of flag leaf was recorded using a handheld SPAD meter (SPAD 502 Plus, Minolta Sensing Inc. Japan). Ten random flag leaves were selected from each plot for measurement of SPAD and the data was then averaged. Only healthier, green and disease free leaves were selected by avoiding the mid-vein.

Canopy temperature (°C): Canopy temperature was determined using an infrared thermometer (Rothenbenger) at heading stage. Data was recorded on clear sunny and calm days between 11:30 AM and 12:30 PM on plots with fully closed canopies. The sensor was held 1 m above the canopy at an angle of 30° to the horizontal. Assessments were made three times and the readings were averaged.

Leaf area index (LAI): This parameter was measured at heading stage by using LAI-2000 (LI-COR, Lincoln, NE).

Normalized differences vegetative index (NDVI): NDVI was measured using the Trimble GreenSeeker handheld crop sensor. Measurements were taken on sunny and cloudless day by passing the sensor over the plots at a height of about 40–50 cm above the canopy.

Statistical analysis: The obtained data were computed for proper statistical analysis according to SAS Program (1998). The LSD at 5% level of significance was used to differentiate between means.

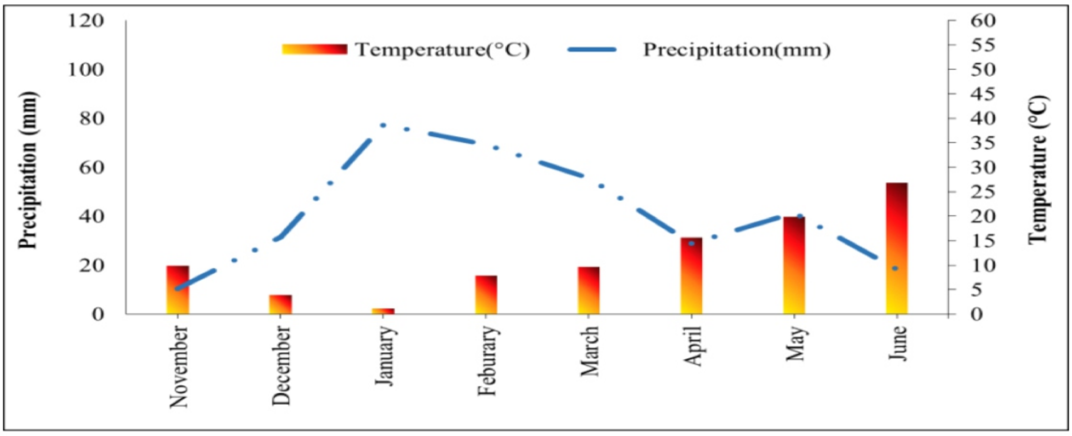

Figure 1. Monthly mean temperature and precipitation at Diyarbakir in the 2014-2015

Results and Discussion

Chlorophyll content (SPAD)

Chlorophyll content is an indication for stay green or leaf senescence in agricultural research projects (Kizilgeci, 2019). Statistically significant differences were shown among bread wheat genotypes for SPAD. The results of this study showed that the chlorophyll content in all genotypes were varied significantly. The highest SPAD value (47.38) was obtained from 'Envoy'. Meanwhile, the lowest (39.85) was recorded from 'Emu Rock' (Figure 2 & Table 1). Chlorophyll content could be use as indicator to determine the performance of photosynthetic rate and reflect photosynthetic potential and primary production (Anjum et al., 2011). Reynolds and Trethowan (2007) reported that chlorophyll content or stay-green was correlated with the transpiration efficiency, which affects to the enhancement of water use efficiency under drought stress conditions. Grain yield had a significant positive relationship with leaf area and leaf chlorophyll content, and the correlation between leaf area and leaf chlorophyll content was also positive. Furthermore, the chlorophyll content can simultaneously increase grain yield, and plants with large leaves and grate chlorophyll content can also produce higher grain yield (Yeganehpoor et al., 2016).

Canopy temperature (CT)

CT measurement is very simple by using an infrared thermometer, which in few seconds can determine the surface temperature of a field plot and it can be used as an indirect selection criterion for grain yield under certain environmental conditions. In the current study significant differences were observed among genotypes for canopy temperature.

The highest CT was recorded in 'Carack' (22.75 °C) and the lowest in 'Calingiri' (20.48 °C). The means of bread wheat varieties was found 21.87 °C (Figure 2 & Table 1). A lower canopy temperature has been linked to improved yield under heat stress (Reynolds et al., 2007; Bahar et al., 2011; Pinto and Reynolds, 2015; Deery et al., 2016; Öztürk and Aydın, 2017). Presumably genotypes with cooler canopies have the ability to extract more soil water (Reynolds et al., 2007). Lower canopy temperature has been previously linked to higher transpiration rates and therefore improved carbon capture and allocation efficiency and ultimately higher yields (Pinto et al., 2010; Cossani and Reynolds, 2015).

Normalized difference vegetation index (NDVI)

Spectral reflectance indices are important tools for evaluating photosynthetic traits. NDVI is one of the maximum broadly utilized vegetation indices as an indicator of canopy green area and it is associated with grain yield as well (Tanriverdi, 2003; Reynolds et al., 2007a; Kizilgeci et al., 2018). The differences among the bread wheat varieties were statistically significant for NDVI. The maximum NDVI value (0.772) was recorded in 'Pehlivan' and the minimum NDVI value (0.638) was recorded in 'Wyalkatchem' (Figure 2 & Table 1). The average NDVI of bread wheat varieties was 0.704. Crusiol et al., (2016) reported that NDVI estimates are affected by many factors, such as measuring stage, sensors and environment. Spectral reflectance NDVI is associated with yield and can be used to estimate stay-green (Lopes and Reynolds, 2012; Magney et al., 2016; Pinto et al., 2016; Rebetzke et al., 2016).

Plant height and leaf area index (LAI)

Plant height is a significant agronomic feature in bread wheat because of its closely associated with lodging. Plant height is also controlled by growing environment and also many genes. In the present study plant height was varied significantly for all genotypes under the ecological condition of Diyarbakir, Turkey. Among the genotypes, the maximum plant height was recorded in 'Pehlivan' (91.75 cm), while the minimum was recorded in 'LPB 08-1799' (55.00 cm). Turkish origin cultivars were taller than the Australian cultivars. Aykut et al., (2005) reported in a recent study that optimum plant height of wheat varieties have varied significantly from 70 to 100 cm, due to the genetic makeup of the specific varieties and also their interaction with growing environmental conditions.

Considering on the leaf area index of fourteen wheat genotypes, significant ($p \leq 0.01$) differences were found among cultivars. The highest LAI (3.83) was recorded from 'Magenta', while the minimum (2.78) was recorded from 'Seri 2013' (Figure 3 & Table 1).

Protein, starch and wet gluten content

The protein content is an inherent trait that can be influenced significantly by cultural practices, nitrogen practices and environmental factors. The differences among the bread wheat cultivars were statistically significant for protein content. The protein content varied between 14.36% ('Calingiri') and 16.48% ('Seri 2013') with an average of 15.41%. Previous bread wheat related researches reported the significant differences for protein content among genotypes which supports our results. Amanlıyev and İşankulıyev (2005) reported that the protein ratio of bread wheat at international standards is accepted as 12.5% (Figure 4 & Table 1).

Starch is also major constituent of the wheat grain. a significant difference was observed among cultivars. The maximum starch content (65.86%) was recorded in 'Calingiri' while, the minimum starch content (62.99 %) was recorded in 'Magenta' (Figure 4).

While wet gluten is the main factor in determining the quality of bread in bread wheat, it constitutes almost 80 percent of the total protein in grain. The data related to wet gluten content for all observed cultivars were given in Table 1. In the study, wet gluten of all genotypes was varied significantly. The value of wet gluten was the highest at 'Seri 2013' (29.37) and the lowest wet gluten was recorded in 'Calingiri' (24.82) (Figure 4 & Table 1).

Zeleny Sedimentation and grain hardness

Zeleny Sedimentation value is an important feature that gives information about gluten quality of wheat flour (Ozen and Akman 2015). In the present study, Zeleny Sedimentation value for all genotypes were varied significantly under the ecological condition of Diyarbakir, Turkey. The zeleny sedimantation value of cultivars ranged from 43.01 ml ('Ceyhan 99') to 50.92 ml (Seri 82 and 'Magenta') (Figure 5 & Table 1).

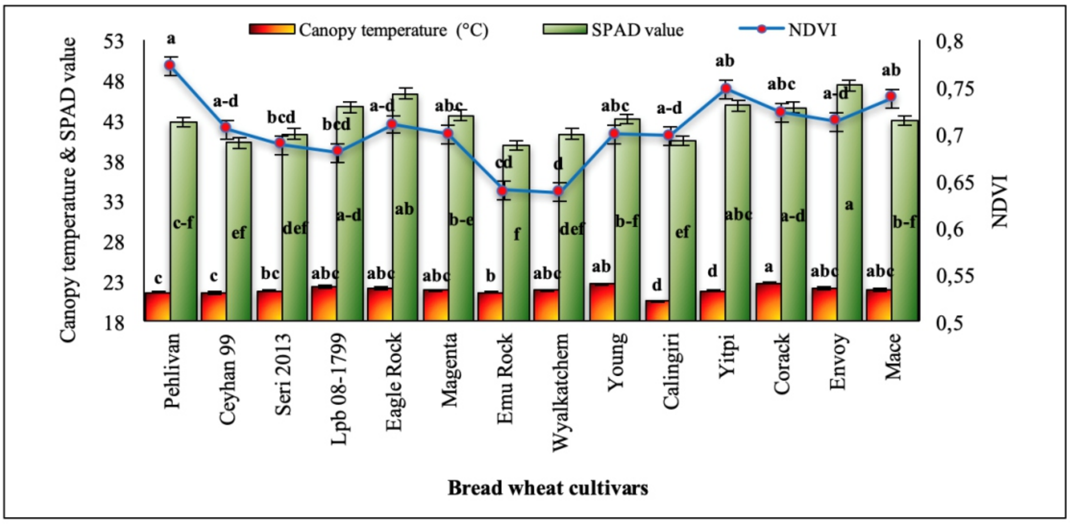

Figure 2. Chlorophyll content (SPAD), Canopy temperature (CT) and normalized difference vegetation index (NDVI) of bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

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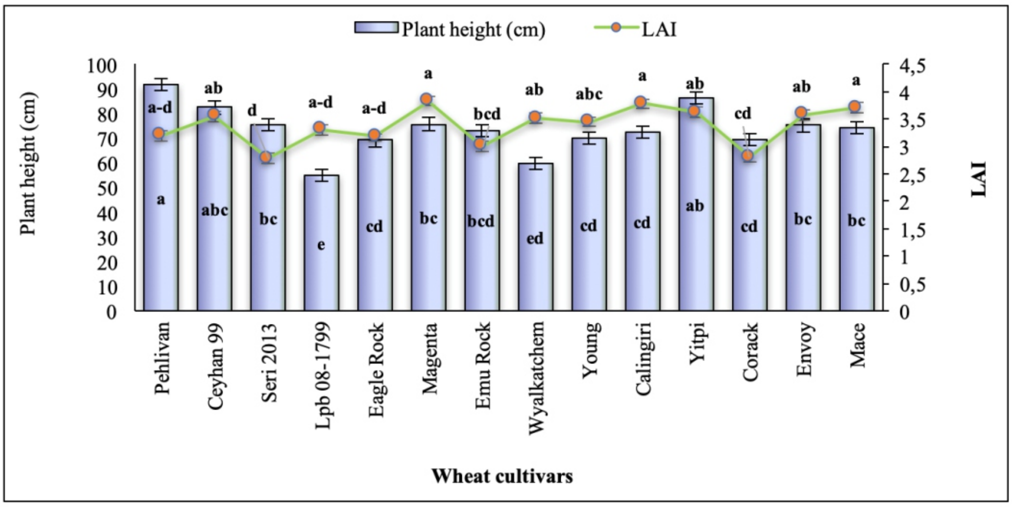

Figure 3. Plant height and leaf area index (LAI) of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

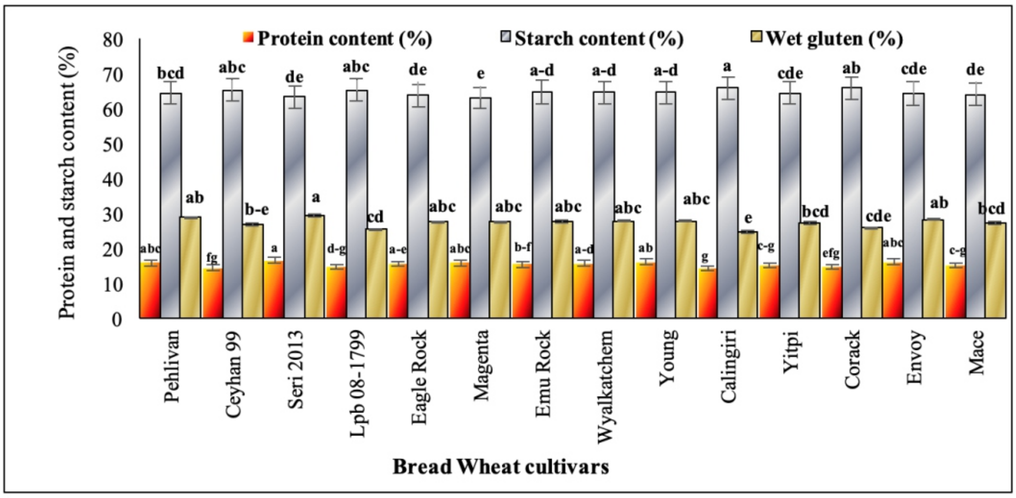

Figure 4. Protein, starch and wet gluten (%) content of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

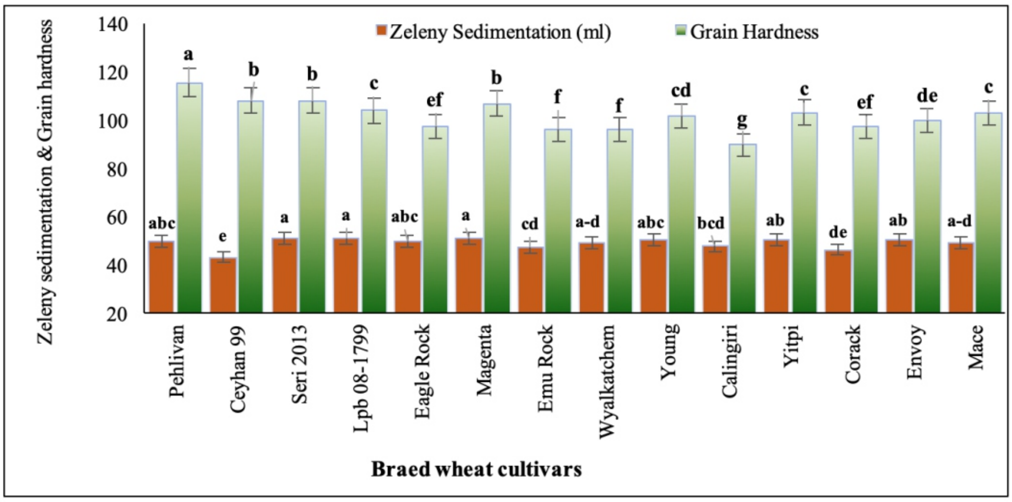

Figure 5. Zeleny sedimentation and grain hardness of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

Table 1. Mean data of investigated traits for bread wheat cultivars

	NDVI	CT (°C)	SPAD	LAI	PH (cm)	PC (%)	SC (%)	WG (%)	ZS (ml)	Grain Hardness	TW (kg hl^{-1})	TKW (g)	Grain Yield (kg ha^{-1})
Pehlivan	0.772a	21.60c	42.75c-f	3.20a-d	91.75a	15.85abc	64.42bcd	28.78ab	49.67abc	115.23a	84.40abc	37.51a	4304.9b-e
Ceyhan 99	0.705a-d	21.55c	40.20ef	3.55ab	82.50abc	14.47fg	65.28abc	26.85b-e	43.01e	107.90b	83.89bc	31.18cde	4484.0a-d
Seri 2013	0.688bcd	21.80 bc	41.35def	2.78d	75.50bc	16.48a	63.36de	29.37a	50.92a	107.93b	84.78abc	33.60b	3859.0c-g
Lpb 08-1799	0.680bcd	22.27abc	44.65a-d	3.30a-d	55.00e	14.77d-g	65.34abc	25.35ed	50.81a	103.9c	86.33a	32.32bc	4097.9 c-f
Eagle Rock	0.710a-d	22.10abc	46.35ab	3.18a-d	69.25cd	15.63a-e	63.74de	27.50abc	49.84abc	97.27ef	84.13abc	28.08fg	3702.1efg
Magenta	0.700abc	21.83abc	43.65b-e	3.83a	75.75bc	15.85abc	62.99e	27.51abc	50.92a	106.60b	84.13abc	30.14ed	3854.9c-g
Emu Rock	0.648cd	21.60b	39.85f	3.00bcd	73.25bcd	15.36b-f	64.69a-d	27.65abc	47.01cd	95.97f	83.77bc	33.48b	3716.0 d-g
Wyalkatchem	0.638d	21.85abc	41.33def	3.53ab	59.75ed	15.68a-d	64.55a-d	27.87abc	49.08a-d	96.04f	83.75bc	25.49h	2793.8h
Young	0.700abc	22.60ab	43.13b-f	3.45abc	70.00cd	16.19ab	64.62a-d	27.85abc	50.02abc	101.62cd	84.50abc	29.46ef	3511.1 fgh
Calingiri	0.698a-d	20.48d	40.43ef	3.78a	72.50cd	14.36g	65.86a	24.82e	47.49bcd	89.58g	80.01d	27.16gh	3238.9 gh
Yitpi	0.748ab	21.78bc	44.85abc	3.63ab	86.50ab	15.22c-g	64.36cde	27.26bcd	50.24ab	102.9c	83.66bc	33.03bc	4554.9abc
Corack	0.723abc	22.75a	44.63a-d	2.80cd	69.50cd	14.71efg	65.80ab	25.80cde	46.08de	97.13ef	83.99abc	30.10de	4146.5c-f
Envoy	0.713a-d	22.07abc	47.38a	3.58ab	75.25bc	16.06abc	64.28cde	28.32ab	50.41ab	99.39de	85.09ab	32.39bc	5038.9ab
Mace	0.738ab	21.90abc	42.98b-f	3.70a	74.25bc	15.15c-g	63.96de	27.16bcd	49.25a-d	102.76c	82.52c	31.99bcd	5204.2a
Mean	0.704	21.87	43.11	3.38	73.62	15.41	64.52	27.29	48.91	101.73	83.93	31.14	4036.2
LSD (5%)	0.079*	0.94**	3.45**	0.65*	13.82**	0.95***	1.39***	2.10**	3.21**	2.43**	2.35**	1.99***	773.8**
CV (%)	7.87	3.04	5.60	13.6	13.12	13.41	4.48	4.35	1.51	5.38	4.59	1.67	1.96

*,**,*** significant at %5, %1, %0.1 respectively. NDVI: Normalized differences vegetative index, CT: Canopy temperature; LAI: Leaf area index, PH: Plant height, PC: Protein content, SC: Starch content, WG: Wet gluten, ZS: Zeleny Sedimentation, TW. Test weight TKW: Thousand kernel weight

Grain hardness is one the most important traits that determine the end-use quality of wheat and its technological utilization. Usually wheats called soft and hard bread wheat. Flour yields of hard wheat are higher than soft wheat. Significant differences were showed among the cultivars for grain hardness. The highest grain hardness was obtained from 'Pehlivan' (115.23), while the lowest grain hardness obtained from 'Calingiri' (89.58). The grain hardness values indicate the softness as close to 100. Aydoğan and Soylu (2016) stated that grain hardness is a genetic factor and is not affected by environmental conditions.

Test weight and 1000-kernel weight

Test weight is one of the factors the most important effect on the quality of wheat. Test weight was statistically significantly differed between cultivars. The highest test weight value in this study was found in genotype 'LPB 08-1799' (86.33 kg hl^{-1}). While, the lowest test weight value was determined in 'Calingiri' (80.01 kg hl^{-1}) (Figure 6 & Table 1). Test weight is affected by several factors, such as genotype, environment, disease, cultural applications (Şener et al., 1997; Taghouti ve ark., 2010; Kızılgeçi, 2018).

Significant differences (p≤0.01) in the mean of 1000-kernel weight were found among bread wheat cultivars (Figure 6). Thousand kernel weight ranged from 25.49g ('Wyalkatchem') to 37.51g ('Pehlivan'). In terms of this trait, it was showed that varieties of Turkish origin have above average values.

Grain yield

The grain yield is considered a major parameter for screening wheat genotypes in breeding programs (Forgone, 2009). Grain yield in bread wheat is a complex character with several components, including genetic and environmental conditions. In terms of grain yield, differences among cultivars were found significant. The maximum grain yield was obtained from genotype 'Wyalkatchem', with 5204.2 kg ha^{-1}, whereas the minimum grain yield was obtained from 'Mace' with 2793.8 kg ha^{-1} (Figure 7 & Table 1).

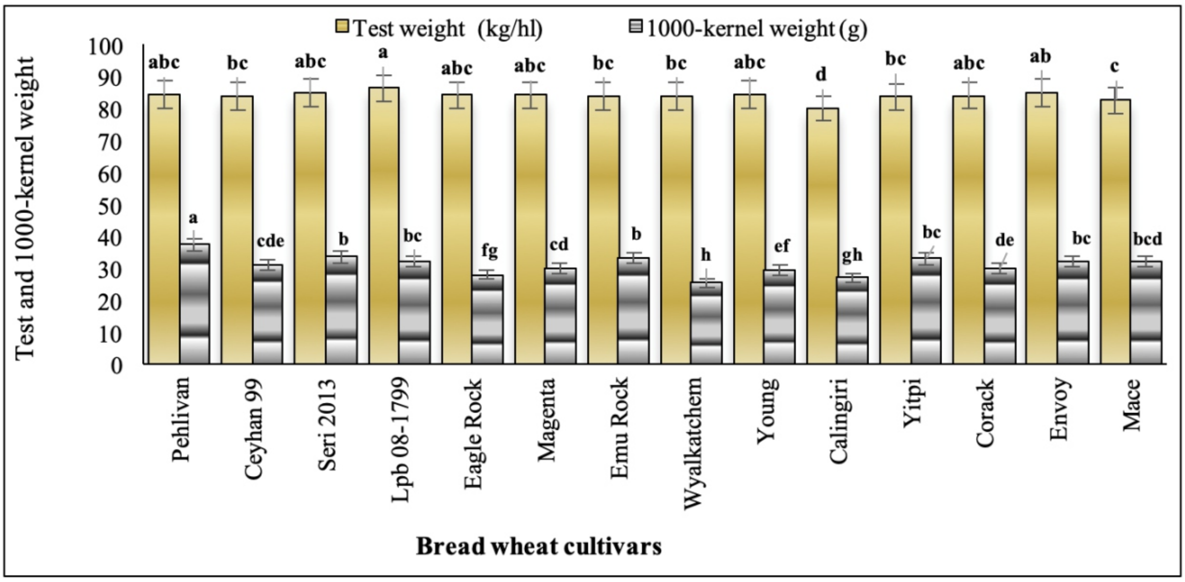

Figure 6. Test weight and 1000-kernel weight of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

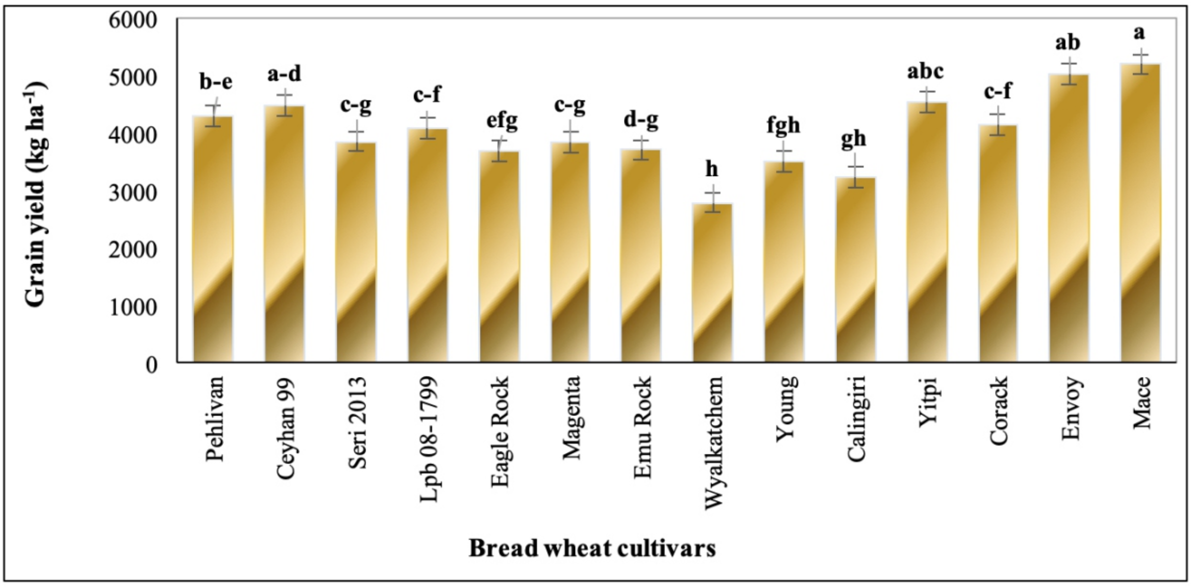

Figure 7. Grain yield (kg ha^{-1}) of fourteen bread wheat cultivar under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

Conclusion

From the results and discussion of the study, it was found that grain yield, grain hardness, test weight, thousand kernel weight, plant height, wet gluten, protein content, zeleny sedimentation, starch content, NDVI, SPAD, LAI and canopy temperature of fourteen wheat bread genotypes were changed according to cultivars under the ecological conditions of Diyarbakir-Turkey. However, genotypes which were from Australian origin performed the best than Turkish origin. Among the genotypes, the maximum values for grain yield, quality and physiological parameters was recorded for genotype, 'Mace' (for grain yield) and 'Young' (for quality traits). Therefore, cultivars which were Australian origin can be grown and also may be used in the breeding programs for these valuable traits, under the Diyarbakir ecological conditions of Turkey.

Conflict of interest

Authors declared no conflict of interest

References

Amanlıyev, A. İşankulıyev, H., (2005), Tahıllar, okul kitabı (gollanma), S.A. Niyazov Tarım Üniversitesi, Aşgabat-2005, 35-38 (in Turkish).

Anjum, S.A., Xie, X.Y., Wang, L.C., Saleem, M.F., Man, C., Lei, W. (2011). Morphological, physiological and biochemical responses of plants to drought stress. Afr. J. Agr. Res., 6(9), 2026-2032. [Google Scholar]

Aykut, F., Yüce, S., Demir, İ., Akçalı Can, R.R., Furan, M.A., (2005). Ekmeklik Buğday Çeşit ve Hatlarının Bornova Koşullarında Performansları. Türkiye VI. Tarla Bitkileri Kongresi, 5-9 Eylül, Antalya, 89-93 (in Turkish).

Aydoğan, S., Soylu, S. (2016). Yetiştirme koşullarının bazı ekmeklik buğday çeşitlerinin kalite özelliklerine etkisi. Selçuk Tarım Bilimleri Dergisi, 2(2), 123-127. [Google Scholar]

Bahar, B., Yildirim, M., Yucel, C. (2011). Heat and drought resistance criteria in spring bread wheat (Triticum aestivum L.): Morpho-physiological parameters for heat tolerance. Scientific Research and Essays, 6(10), 2212-2220. [CrossRef]

Bockus, W.W., Bowden, R.L., Hunger, R.M., Murray, T.D., Smiley, R.W. (2010). Compendium of wheat diseases and pests (No. Ed. 3). American Phytopathological Society (APS Press).

Breiman, A., Graur, D. (1995). Wheat evolution. Israel Journal of Plant Sciences, 43(2), 85-98. [CrossRef]

Cossani, C.M., Reynolds, M.P. (2015). Heat stress adaptation in elite lines derived from synthetic hexaploid wheat. Crop Science, 55(6), 2719-2735. [CrossRef]

Crusiol, L.G.T., Carvalho, J. de F.C., Sibaldelli, R.N.R., Neiverth, W., Rio, A. do, Ferreira, L.C., Procópio, S. de O., Mertz-Henning, L.M., Nepomuceno, A.L., Neumaier, N., Farias, J.R.B. (2017). NDVI variation according to the time of measurement, sampling size, positioning of sensor and water regime in different soybean cultivars. Precis. Agric., 18:470. [CrossRef]

Deery, D.M., Rebetzke, G.J., Jimenez-Berni, J.A., James, R.A., Condon, A.G., Bovill, W.D., Hutchinson,P., Scarrow, J., Davy, R., Furbank, R.T. (2016). Methodology for high-throughput field phenotyping of canopy temperature using airborne thermography. Frontiers in plant science, 7, 1808. [CrossRef]

FAOSTAT, 2017. FAO Database. http://www.fao.org/faostat/en/ [Access Date: 01 January 2019]

Forgone, A.G. (2009). Physiological indicators of drought tolerance of wheat. Biology PhD Program. University of Szeged Faculty of Science and Informatics Department of plant Biology, Szeged.

Hossain, M.M., Hossain, A., Alam, M.A., EL Sabagh, A., Khandakar Faisal Ibn Murad, Haque, M.M., Muriruzzaman, M., Islam, M.Z. Das, S. Barutcular, C., Kizilgeci, F. (2018) Evaluation of fifty spring wheat genotypes grown under heat stress condition in multiple environments of Bangladesh. Fresen. Environ. Bull., 27, 5993-6004.

Kizilgeci, F., Yildirim, M., Akinci, C., Albayrak, O., Sesiz, U., Tazebay, N. (2018). Evaluation of relationships between yield and yield components with physiological parameters in barley (Hordeum vulgare L.) genotypes. Dicle University Journal of Institute of Natural and Applied Science, 7(2), 61-66

Kizilgeci, F. (2019). Post-anthesis changes in chlorophyll and agronomic traits of bread wheat genotypes. Applied Ecology And Environmental Research, 17(2),1913-1922.

Kumar, P., Yadava, R.K., Gollen, B., Kumar, S., Verma, R.K., Yadav, S. (2011). Nutritional contents and medicinal properties of wheat: a review. Life Sciences and Medicine Research, 22, 1-10. [Google Scholar]

Lopes, M.S., Reynolds, M.P. (2012). Stay-green in spring wheat can be determined by spectral reflectance measurements (normalized difference vegetation index) independently from phenology. Journal of experimental botany, 63(10), 3789-3798. [CrossRef]

Magney, T.S., Eitel, J.U.H., Huggins, D.R., Vierling, L.A. (2016). Proximal NDVI derived phenology improves in-season predictions of wheat quantity and quality. Agric. For. Meteorol., 217, 46–60. [CrossRef]

Ozen, S., Akman, Z. (2014). Determination of Yield and Quality Characteristics of Some Bread Wheat Cultivars in Yozgat Ecological Conditions. SDÜ Ziraat Fakültesi Dergisi, 2(1), 35-43. [CABI] [Google Scholar]

Öztürk, A., Aydın, M. (2017). Physiological characterization of Turkish bread wheat genotypes for resistance to late drought stress. Turkish Journal of Agriculture and Forestry, 41(6), 414-440. [Google Scholar]

Pinto, R.S., Reynolds, M.P., Mathews, K.L., McIntyre, C.L., Olivares-Villegas, J.-J., Chapman, S.C. (2010). Heat and drought adaptive QTL in a wheat population designed to minimize confounding agronomic effects. Theor. Appl. Genet., 121, 1001–1021. [CrossRef]

Pinto, R.S., Reynolds, M.P. (2015). Common genetic basis for canopy temperature depression under heat and drought stress associated with optimized root distribution in bread wheat. Theoretical and Applied Genetics, 128(4), 575-585. [CrossRef]

Pinto, R.S., Lopes, M.S., Collins, N.C., Reynolds, M.P. (2016). Modelling and genetic dissection of staygreen under heat stress. Theor. Appl. Genet., 129:2055. [CrossRef]

Rebetzke, G.J., Jimenez-Berni, J.A., Bovill, W.D., Deery, D.M., James, R.A. (2016). High-throughput phenotyping technologies allow accurate selection of stay-green. Journal of experimental botany, 67(17), 4919-4924. [CrossRef]

Reynolds, J.F., Smith, D.M.S., Lambin, E.F., Turner, B.L., Mortimore, M., Batterbury, S. P.J., Walker, B. (2007). Global desertification: Building a science for dryland development. Science, 316, 847–851. [CrossRef]

Reynolds M.P., Trethowan R.M. (2007). Physiological interventions in breeding for adaptation to abiotic stress, In J. H. J. Spiertz et al. (ed) Scale and complexity in plant systems research, gene-plant-crop relations. Springer, Dordrecht, the Netherlands. [Google Scholar]

Shewry, P. R. (2009). Wheat. Journal of Experimental Botany, 60(6), 1537-1553. [CrossRef]

Šramková, Z., Gregová, E., Šturdík, E. (2009). Chemical composition and nutritional quality of wheat grain. Acta Chimica Slovaca, *2*(1), 115-138. [Google Scholar]

Şener, O., Kılınç M., Yağbasanlar T., Gözübenli, H., Karadavut, U., (1997). Hatay koşullarında bazı ekmeklik (Triticum aestivum L. Em Thell) ve makarnalık buğday (Triticum durum Desf) çeşit ve hatlarının saptanması. Türkiye II. Tarla Bitkileri Kongresi, 22 – 25 Eylül 1997, Samsun, 1-5. (in Turkish).

Taghouti, M., Gaboun, F., Nsarellah, N., Rhrib, R., El- Haila, M., Kamar, M., Abbad -Andaloussi F. and Udupa S. M. (2010). Genotype x Environment interaction for quality traits in durum wheat cultivars adapted to different environments. African Journal of Biotechnology, 9(21), 3054-3062. [Google Scholar]

Tanrıverdi, C. 2003. Available water effects on water stress indices for irrigated corn grown in sandy soils. Ph. D. Thesis, Department of Chemical and Bioresource Engineering, Colorado State University,

Wijngaard, H.H., Arendt, E.K., (2006). Buckwheat. Cereal Chemistry 83 (4), 391-401. [CrossRef]

Yildirim , M., Barutcular, C., Koc, M., Dizlek, H., EL Sabagh, A., Hossain, A., Islam, M.S, Toptas I., Basdemir F., Albayrak O., Akinci, C. (2018). Assessment of the grain quality of wheat genotypes grown under multiple environments using GGE biplot analysis. Fresenius Environmental Bulletin, 27(7), 4830-4837. [Google Scholar]

Yeganehpoor, F., Salmasi, S.Z. Kolvanagh, J. S., Golezani, K.G., Dastborhan, S. (2016). Changes in growth, chlorophyll content and grain yield of Coriander (*Coriandrum sativum* L.) in response to water stress, chemical and biological fertilizers and salicylic acid. Intl. J. Adv. Biol. Biomed. Res., 5(1), 228-236. [CrossRef]