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Determination of Some Quality Characteristics of Durum Wheat under Dry Conditions in Konya

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HIGHLIGHTS

- Wheat is an indispensable product.
- It is necessary to increase the grain yield of wheat.
- Quality is a quantitative character and is influenced by many factors.

Abstract

This study was carried out to determine the quality characteristics of some durum wheat varieties grown in different regions of Turkey under Konya ecological conditions. Altıntaş-95, Burgos, Ç-1252, Dumlupınar, Eminbey, Imren, Kızıltan-91, Kunduru-1149, Leonardo, Levent, Kümbet-2000, Mimmo, Mirzabey-2000, Sırçalı, Soylu, Svevo, Traubadur, Türköz, Vehbibey, Yelken-2000 varieties were used as plant material. In the research, the field trial was established in a randomized block design with three replications. Within the scope of the research; hectoliter weight, glassiness, semolina color and protein characteristics were examined. In the study, significant differences were found between the varieties in terms of hectoliter weight and protein ratio, while semolina color and glassiness were found insignificant. The highest hectoliter weight was found in the Yelken-2000 variety and the highest protein ratio was found in the Burgos variety.

Keywords: Drought, Durum wheat, Glassiness, Semolina color

1. Introduction

Turkey, the homeland of durum wheat as well as many other plants, is ecologically suitable for producing high-quality durum wheat (Bozkurt 2012). Currently, Turkey is an important producer of durum wheat in the Southeastern and Central Anatolia regions and is expected to become even more important in durum wheat production in the coming years. This requires increasing production and the quality of the products produced. In this context, the first thing to be done is to identify the varieties that can be successfully grown in the regions and provinces of Turkey where durum wheat is widely produced. It is known that wheat yield and quality can be increased by 20-30% with the use of appropriate varieties (Geçit 2016).

The quality of durum wheat is closely related to genetic structure, ecological conditions, cultivation technique, and especially the amount of nitrogen fertilizer used and other cultural practices. For this reason, in Konya province, which ranks second after Şanlıurfa in terms of durum wheat cultivation area in Turkey (Geçit 2016), it will be important for both producers, industrialists, and consumers to identify varieties with high yield and quality and to encourage their production. In durum wheat, hectoliter weight is one of the

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important quality traits that gives information about many characteristics of the product such as starch content, spelled content and grain shape (Kandemir 2004). Although hectoliter weight, which is determined by the structure, size, fullness, and homogeneity of the grain, varies mostly according to the variety, it can also be affected by growing conditions (Elgün 2008; Ünal 1991).

One of the important quality characteristics of durum wheat is color (Aydoğan et al. 2012). Banach et al. (2021) stated that durum wheat varieties with high yellow pigment content are of higher quality and the color value is very important in the commercial, nutritional and technological quality evaluation of durum wheat, and that yellow color value is considered an important nutritional resource and is little affected by the environment, but this value increases in years with low rainfall.

The hard, firm, and glassy structure of durum wheat grains is the most important indicator indicating that the protein content of the product is high. For this reason, glassiness is used as an important quality factor in durum wheat in our country and all over the world (Geçit 2016). Hard and glassy grain and durum wheat are often mentioned together, and the glassiness ratio is a physical quality element that can be determined quickly and practically used in the classification of durum wheat in many countries (Türköz 2016). Studies on the subject have shown that the Southeastern Anatolia Region is the most suitable in terms of physical characteristics of the grain, protein content, and glassiness rate (Atlı 1999; Kılıç 2020). Borghi et al. (1997) stated that while hot and dry conditions caused a decrease in yield, they created an advantage in terms of glassiness.

The grain protein content is one of the most important quality criteria in durum wheat (Gooding and Davies 1997) and has a positive effect on glassiness (Borghi et al. 1975). Researchers state that protein content varies partly depending on species and cultivar, but mostly on environmental factors, and generally the protein content of glassy grains is higher than non-glassy grains (Budak et al. 1997; Mut et al. 2007; Yazar and Karadoğan 2008). Kartal et al. (2011) also stated that environmental and growing conditions and soil structure play an important role in determining the protein content of grain.

This study was carried out to determine some quality characteristics of some durum wheat varieties grown in different regions of Turkey under Konya ecological conditions.

2. Materials and Methods

A total of 53 stratiomyids, 21 males and 32 females, were collected from Gevne Valley between the years of 2019 and 2020 (Fig.1). Stratiomyide specimens were captured with an entomological net, then sacrificed in jars containing ethyl acetate and pinned. Their diagnosis was made based on relevant literature. Photographs of each species were taken. The material is now housed at the Selçuk University, Faculty of Science, Department of Biology.

This research was conducted in the experimental field of Konya Bahri Dağdaş International Agricultural Research Institute Directorate during the vegetation period of 2020-2021. Some climatic characteristics of the vegetation period are given in Table 1.

As can be seen from Table 1, the total rainfall for nine months in the experimental year was 181.4 mm, which is 149.4 mm less than the total rainfall of the long years (330.8 mm). In the study, the amount of rainfall in April, May, and June, which coincided with the stalk emergence, flowering, fertilization, and grain-filling periods, known as critical periods in terms of grain yield, was much lower than expected. Similarly, the rainfall regime in the experimental year was more irregular than the long-term average.

Table 1. Climatic values of the vegetation period

Months	2020-2021 *Vegetation Period*					(1929-2020) *Long years*				
	Temp. (°C)			Precip.	Rel. hum.	Temp. (C°)			Precip.	Rel. hum.
	Mean	Max.	Min.	(mm)	(%)	Mean	Max.	Min.	(mm)	(%)
October	16,3	28,7	3,6	13	56	12,6	31,6	-7,6	29,9	58
November	5.8	17.9	-8.1	25	78	6,5	25,2	-20,0	32,2	69
December	4.5	14.6	-7.5	12.6	88	1,6	20,0	-22,4	42,8	77
January	2.5	20.2	-11.2	51.8	85	-0,1	17,6	-25,8	37,9	76
February	2.9	20	-16,5	1.6	67	1,4	21,2	-25,0	28,5	70
March	5.2	31.3	-7.8	31.6	66	5,5	28,9	-15,8	28,7	62
April	12.1	30.2	-1.2	17.4	53	11	31,5	-8,6	31,9	58
May	19.1	33.7	1.7	2.4	38	15,8	33,4	-1,2	43,3	55
June	19.5	32.5	4.3	26	51	20,1	37,2	3,2	25,7	47
Mean /Total	9.7	26.9	-4.7	181.4	60.8	10.4	34.4	-16.7	330.8	61

Source: Bahri Dağdaş International Agricultural Research Institute

The soil of the test area has a clayey texture, a high lime level, and is alkaline. The potassium (K) and phosphorus (P) content of the soil are high and it is poor in organic matter.

In the study, 20 varieties obtained from some private and public institutions were used as plant material. These are Altıntaş-95, Burgos, Ç-1252, Dumlupınar, İmren, Kızıltan-91, Kunduru-1149, Kümbet-2000, Mimmo, Mirzabey-2000, Sırçalı, Svevo, Traubodur, Türköz, Vehbibey, Yelken-2000, Soylu, Eminbey, Leonardo and Levent.

The research was established in a randomized block design with three replications. Each plot was 4 m long, 20 cm between rows, and consisted of six rows. Sowing was done with a seeder on November 12, 2020, and the sowing norm was adjusted to 550 plants per m2. Weeds were controlled with a herbicide containing 2,4-D. 6 kg phosphorus (P2O5) and 15 kg nitrogen (N) were given per decare. In this context, 14 kg of DAP fertilizer (18% nitrogen and 46% phosphorus) was applied before planting. The remaining part of nitrogen was applied in the form of urea (46% nitrogen) before the emergence of stalks. Plants were stressed due to drought during emergence and for this reason, water was given to the plants once on May 10 by flood irrigation. Harvesting was carried out with a plot combine harvester after all varieties matured.

This article was an oral presentation at the "Turkey 13. National - II. International Field Crops Conference (TABKON-2022)" and published as an abstract in the proceedings book (Doruk Kahraman and Gökmen 2022).

The data obtained as a result of the research were subjected to statistical analyses with the computer-based package program named "MSTAT-C" according to the Coincidence Blocks Experimental Design. Accordingly, the comparison of the mean values, which were found to be significant in the F test, was carried out according to the Duncan multiple tests.

3. Results and Discussion

The mean values and Duncan grouping of some durum wheat cultivars grown in different regions of Turkey in Konya ecological conditions are given in Table 2.

3.1. Hectoliter weight

As seen in Table 2, the difference between the varieties in terms of hectoliter weight was statistically significant at a 5% level. The highest hectoliter weight was obtained from the Yelken variety with 82.1 kg and the lowest hectoliter weight was obtained from the Kümbet-2000 variety with 75.9 kg. The hectoliter weights of the other varieties used in the experiment varied between these two values.

Hectoliter weight, which is accepted as a physical quality criterion and used as the easiest measure to determine quality, is especially important in milling (Ünal 2002). It is known that as the hectoliter weight increases, flour yield also increases (Atlı 1999). Hectoliter weight should be 80 kg and above for first-class durum wheat, 78 kg and above for second-class durum wheat, and 76 kg and above for third-class durum wheat (Yürür 1998). When the results obtained from the experiment are examined, it is seen that most of the varieties are in the third class in terms of hectoliter weight. This situation is thought to be caused by drought. Türköz (2016), in his study conducted with durum wheat under Konya conditions, determined that the hectoliter weights of most of the varieties were lower than the third-class durum wheat class and reported that the reason for this decrease in hectoliter weights was insufficient and irregular rainfall during the experiment. Similarly, Guttieri et al. (2001), in a study conducted by applying two different drought stresses to 16 different durum wheat cultivars, observed that the hectoliter weights of the cultivars decreased significantly under stress conditions.

Table 2. Mean values of investigated characteristics and Duncan grouping

Cultivars	Test weight	Semolina color	Vitreousness	Protein content
Altıntaş-95	78.8 bcd*	30.2	97.0	14.1 ıj**
Burgos	78.8 bcd	29.7	97.2	16.9 a
Ç-1252	77.8 cdefg	27.8	98.2	14.2 hı
Dumlupınar	76.8 efgh	28.8	97.6	14.3 gh
İmren	76.4 gh	29.5	97.9	15.3 cd
Kızıltan-91	76.5 fgh	27.2	97.6	15.3 c
Kunduru-1149	76.9 efgh	28.9	96.6	14.4 fg
Kümbet-2000	75.9 h	27.3	96.3	12.7 l
Mimmo	77.3 defgh	28.0	95.0	14.4 fg
Mirzabey-2000	78.4 bcde	28.2	97.5	15.3 c
Sırçalı	76.2 gh	29.0	98.3	13.8 k
Svevo	78.1 cdef	29.2	96.3	12.7 l
Traubodur	77.5 defgh	29.2	97.4	14.8 e
Türköz	79.3 bc	28.8	96.6	15.1d
Vehbibey	76.1 gh	30.1	96.1	14.1 hı
Yelken-2000	82.1 a	27.7	95.6	14.1 ıj
Soylu	77.4 defgh	27.8	98.7	13.9 jk
Eminbey	77.8 cdefg	27.9	97.6	15.6 b
Leonardo	79.9 b	28.8	97.6	14.5 f
Levent	79.3 bc	28.1	95.9	15.2 cd
LSD	1.441	-	-	0.1715

*: 0.05 significance level, **: 0.01 significance level

3.2. Semolina color

The difference between the varieties in terms of semolina color was found statistically insignificant. The highest semolina color was observed in the Altıntaş-95 variety, while the lowest value was obtained from the Kızıltan-91 variety (Table 2). In another study conducted under Konya conditions, it was determined that the Altıntaş-95 variety gave the highest semolina color value (Aydoğan et al. 2012). In another study conducted for two years under dry conditions in Konya and Çumra locations, the researchers found that semolina color varied between 17.11-22.40 (Aydoğan et al. 2012). Although the study was conducted in the same region, it

can be said that the fact that the values obtained in the related study were considerably lower than the values found in our study may be because both studies were conducted in different years, places, and varieties.

In their studies on the subject, Kendal et al. (2012) determined semolina color as 19.7-28.4 and Kaplan Evlice and Özkaya (2019) as 20.56-26.87. It was observed that the semolina color values of the varieties in the experiment were higher than the results of other studies. It is thought that this may be due to climatic characteristics, especially insufficient rainfall. Banach et al. (2021) also reported that although the color value is a trait that is little affected by environmental conditions, this value increases in years with low rainfall. In their study in which they determined grain yellowness (b value), which is an indicator of the content of carotenoid pigments, the researchers stated that the values varied between 26.72-28.84. The results obtained from the study and the values obtained from this study are similar.

3.3. Glassiness

The difference between the varieties in terms of the glassiness ratio was found statistically insignificant. The glassiness rates of durum wheat varieties used in the experiment varied between 95.0-98.7% and the highest glassiness rate was observed in the Soylu variety, while the lowest value was determined in the Mimmo variety. It was observed that all of the varieties used in the experiment had a high glassiness ratio (Table 2). It can be said that the high glassiness rate in the study is due to the high temperature and low rainfall during the grain-filling period (Table 1). In this regard, Borghi et al. (1997) also stated that hot and dry conditions increase the rate of glassiness, although they cause irregularities in yield.

Kılıç (2020), in a study conducted with some durum wheat varieties under Kızıltepe and Diyarbakır conditions, reported that the glassiness rates varied between 74.1- 99.9% and both locations were suitable for durum wheat production. However, the Kızıltepe location is expected to have a high glassiness rate because it is warmer and rainfall is lower than the Diyarbakır location.

3.4. Protein rate

In the study, the difference between the varieties in terms of protein ratio was statistically significant at a 1% level. The highest protein rate was determined in the Burgos variety with 16,9% and the lowest was determined in the Kümbet-2000 variety with 12,7%. The protein rate of the other varieties in the experiment was between these values.

The variation in the protein ratio of varieties grown under the same conditions is due to the different genetic structures of the varieties and their responses to ecological conditions. Similarly, Gökmen (1989) reported that protein ratio varies primarily depending on a variety of characteristics. On the other hand, Çölkesen et al. (1993) reported that the protein ratio in wheat varies partly depending on the species and variety, but

mostly on environmental factors; generally, the protein ratio of glassy grains is higher than non-glassy grains. In this study, the fact that the varieties with a high glassy grain ratio also had a high protein ratio is by the findings of Çölkesen et al. (1993). Campbell et al. (1981) stated that the highest protein contents usually occur under unfavorable conditions. Although insufficient rainfall and hot weather in the year of the experiment (Table 1) negatively affected many traits, the fact that the protein contents of the varieties were within the desired limits confirms this information.

The hectoliter weight of the Kümbet-2000 variety with the lowest protein ratio was also found to be the lowest (Table 2). The high hectoliter weight is related to the hard structure of the grain and therefore the high protein content (Kün, 1988). Ateş Sönmezoğlu (2010) and Çevik (2018) stated that the protein ratio increased with decreasing thousand-grain weight. This information is confirmed by the fact that Ç-1252 and Sırçalı varieties showed low values in terms of protein ratio although their thousand-grain weights were high. There are other findings that the protein ratio increases with decreasing thousand-grain weight (Weston et al. 1993; Gürsoy, 2011; Kartal et al., 2011; Kon, 2019).

4. Conclusions

In this study, the Gevne Valley's Stratiomyidae fauna have been determined in the Gevne Valley, which is a very isolated area. It is important to conduct similar faunistic studies at certain intervals in the future to monitor these species.

The results obtained from this study, which was carried out to determine some quality characteristics of 20 durum wheat varieties grown in different regions of Turkey under Konya conditions and some suggestions that can be made on the subject are summarized below.

Due to the severe drought experienced during the growing period, the traits studied in this research were found to be different from most of the studies conducted in Turkey on the subject.

Drought caused by insufficient rainfall and high temperatures during the period starting from the emergence of stalks until the maturity of the plants affected glassiness, protein ratio, and semolina color, which are important quality traits of durum wheat, positively, and hectoliter weight negatively. Since the grain yield is very low, it seems possible to say that the increase in quality characteristics is an advantage in practice. Since there was an extreme drought during the growing period in which the research was conducted, it does not seem possible to make any variety of recommendations. For this reason, it would be better to carry out the study for at least a few years and make a variety of recommendations as a result.

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Conflicts of Interest: The authors declare no conflict of interest.

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