Variation in grain yield and quality of romanian bread wheat varieties compared to local varieties in northwestern turkey

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ŞEMUN TAYYAR*
Çanakkale Onsekiz Mart University, Biga Vocational College, 17200, Biga-Çanakkale/TURKEY
*Corresponding author: Şemun Tayyar, Ph.D., Assistant Professor, Çanakkale Onsekiz Mart University, Biga Vocational College, 17200, Biga-Çanakkale/TURKEY, Tel: +90 286 3162878, Fax: +90 286 3163733, E-mail: stayyar@comu.edu.tr

Abstract
Fourteen bread wheat varieties, 12 introduced from Romania and two local Turkish ones were investigated in Northwestern Turkey for grain yield and grain quality in order to determine the most suitable and superior new wheat varieties for the region. The varieties were grown in two successive growing seasons (2005-2006 / 2006-2007) in a completely randomized block experimental design with three replications. Significant differences in grain yield and quality parameters such as protein, gluten, gluten index, sedimentation, modified sedimentation, hectoliter weight and grain moisture were found between the two local and introduced varieties. Significant genotype x year interactions was observed for all the traits examined except for protein, grain moisture and hectoliter weight. The grain yield of local varieties, Gönen and Saqittario was 454.4 kg da⁻¹ and 419.4 kg da⁻¹, respectively. The highest grain yield was obtained from introduced Romanian variety of Joseph (475.5 kg da⁻¹) whereas Turda (344.0 kg da⁻¹) and Eliva (348.2 kg da⁻¹) gave the lowest grain yield. The highest grain protein content was 12.78% for Ardeal and the lowest 10.85% for Gabriela. Correlation coefficients analyses revealed negative relationships between grain yield and gluten (-0.311**), sedimentation (-0.362***), and modified sedimentation (-0.265*), and positive relationships between grain yield and hectoliter weight (0.312**). Protein was positively associated with gluten (0.275**) and modified sedimentation (0.253*). No relationships were observed between grain moisture and other investigated traits. The studies suggest that the Romanian bread wheat variety, Joseph with higher grain yield and better quality characters in comparison with local varieties could be a new variety for the Northwestern region of Turkey.

Keywords: Triticum aestivum L., protein content, gluten, gluten index, flour industry, correlation

Introduction
More than 6 billion people consume approximately 11 g of nitrogen (N) person day⁻¹ [1] with 80% of dietary needs in large areas over the world and earth population being provided by the plants. However with human population expected to reach 8.3 billion by 2025 [2] coupled with continuous deterioration and losses of agricultural lands, it has become imperative to have crop production with higher yield and good quality ought to be achieved to feed the millions.

Bread wheat (Triticum aestivum L.) is one of the most widely grown and most consumed food crops all over the world. It is also a major field crop in Turkey grown in 8 090 000 ha area producing 17 782 000 tons production and 220 kg da⁻¹ grain yield in 2008 [3]. Compared with other cereals, it provides food for human with more calories and proteins in the daily diet, a considerable amount of trade throughout the world, and a lot of other products. Its suitability and superiority in breadmaking with viscoelastic dough properties has been well known and documented [4-7].

The developments of high grain yield potential with good breadmaking quality and resistance to biotic and/or abiotic stress factors and which respond to improved agricultural practices are the main achievements for bread wheat breeding programmes. In the last few decades, efforts taken by wheat breeders have resulted in successful development of bread
wheat varieties possessing higher grain yielding potential, improved resistance to pest and diseases and better quality parameters.

The grain protein content of wheat is a critical factor in breadmaking and high protein content of wheat is associated with good breadmaking characteristics [6-11]. It is genetically controlled but may vary widely depending upon the variety, climatic conditions, location, soil fertility, etc and the complex interactions between these factors. In general, high protein flours give rise to better results since they have a high loaf volume potential with higher water absorption. Genotype-by-environment (G x E) interactions and the negative correlation between grain yield and grain protein content of wheat had been established in different studies [11-15]. If a genotype has a high stability and shows low interactions with the environment is desirable in plant breeding.

The objective of the present investigation was to study the grain yield and grain quality of the varieties, to compare the local varieties with introduced Romanian varieties in respect of higher grain yield with quality traits, and to examine the correlation coefficients between grain yield and grain quality parameters. Results are interpreted in relation to grain yield with superior grain quality characteristics compared to the local control varieties to select new bread wheat variety and/or varieties originating from Romania suitable for the region. This may be more important, where a higher price is paid for high protein content which means more income for the producers and, where a better raw material demands for the flour industry as well.

Materials and methods

The introduced and local varieties were sown at Aşağı Demirci, Biga, Northwest part of Turkey, in 2005-2006 and 2006-2007. The soil was clay-loam having a pH 6.3 containing 0.81% lime and 3.0% organic matter [16]. The experiment involved fourteen bread wheat varieties, twelve of which obtained from University of Agronomical Sciences and Veterinary Medicine, Bucharest/Romania (Apullum, Ardeal, Boema, Crina, Dumbrava, Eliva, Fundulea, Gabriela, Joseph, Simnic, Trivale and Turda). The local varieties, Gönen and Saqittario, commonly cultivated by the growers in the region were chosen as control varieties. The average maximum temperature, average minimum temperature and average temperature, and total rainfall prevailing in Çanakkale province is given in Table 1 [17].

<table>
<thead>
<tr>
<th>Months</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average maximum temperature (°C) Long</td>
<td>9.7</td>
<td>9.8</td>
<td>12.3</td>
<td>16.9</td>
<td>22.3</td>
<td>27.7</td>
<td>30.5</td>
<td>30.1</td>
<td>26.1</td>
<td>20.6</td>
<td>15.2</td>
<td>11.2</td>
</tr>
<tr>
<td>Average temperature (°C) Long</td>
<td>6.4</td>
<td>6.4</td>
<td>8.3</td>
<td>12.5</td>
<td>17.4</td>
<td>22.3</td>
<td>25.0</td>
<td>24.7</td>
<td>20.8</td>
<td>16.0</td>
<td>11.4</td>
<td>8.1</td>
</tr>
<tr>
<td>Average minimum temperature (°C) Long</td>
<td>3.3</td>
<td>3.3</td>
<td>4.8</td>
<td>8.6</td>
<td>12.9</td>
<td>17.0</td>
<td>19.6</td>
<td>19.6</td>
<td>16.0</td>
<td>12.1</td>
<td>8.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Total rainfall (mm) Long</td>
<td>86.8</td>
<td>62.7</td>
<td>66.5</td>
<td>48.2</td>
<td>34.2</td>
<td>21.3</td>
<td>12.7</td>
<td>4.0</td>
<td>18.3</td>
<td>46.0</td>
<td>93.2</td>
<td>101.8</td>
</tr>
</tbody>
</table>

Long year’s data was between the years of 1975-2007.
The experiment was designed as a completely randomized block with three replicates. All plots were seeded at a rate of approximately 500 seeds m\(^{-2}\). The plots consisted of five 5 m rows, spaced at a distance of 20 cm. All trials were taken up with sowing of seeds at the end of November and harvesting at the beginning of July. The total (120 kg ha\(^{-1}\)) amount of N was applied in split, ½ at sowing and ½ in the beginning of stem elongation of the crop. The P dose (70 kg ha\(^{-1}\)) was given at sowing. Post emergence herbicides were applied for weed control. In order to avoid edge effects, the data recorded on grain yield was obtained from the three center rows in each plot. The harvested grain was subjected to quality analyses in triplicate. Grain samples from three replicates of the varieties investigated were evaluated for quality characteristics. Determination of test weight and grain moisture was determined by standards. Grain protein content of the seeds was determined by Kjeldahl method. Wheat samples, tempered to 15.5%, were milled on a Chopin mill (Moulin Cd Type). The whole wheat flour of each variety was tested for gluten (GL), gluten index (GI) and sedimentation (S) according to the standard methods described in ICC [18-20]. Modified sedimentation (MS) was done following the procedure of Atlı et al [21]. Statistical analyses of data were performed using the PROC GLM and PROC CORR procedure of SAS [22]. Least significant difference (LSD) was used to compare mean values of the characteristics studied.

**Results**

The results from analyses of variance over two years for the investigated characteristics are presented in Table 2. Effects of genotype (G) and year (Y) were found to be significant for all the parameters, except the effect of year for grain moisture. G x Y was also significant except for grain moisture, hectoliter weight and protein content. Table 3 presents mean values of the 1st year and 2nd year of the characteristics studied. Except for grain moisture, the differences between the two years were significant.

**Table 2. Analysis of variance for grain yield and quality traits studied over two years**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>GY Mean square</th>
<th>M Mean square</th>
<th>HW Mean square</th>
<th>P Mean square</th>
<th>GL Mean square</th>
<th>GI Mean square</th>
<th>S Mean square</th>
<th>MS Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genotype (G)</td>
<td>13</td>
<td>10161.5***</td>
<td>0.51*</td>
<td>12.1***</td>
<td>1.69***</td>
<td>35.1***</td>
<td>1707.0***</td>
<td>441.7***</td>
<td>480.6***</td>
</tr>
<tr>
<td>Year (Y)</td>
<td>1</td>
<td>118778.4***</td>
<td>0.94</td>
<td>35.9***</td>
<td>10.86***</td>
<td>10.3*</td>
<td>565.8***</td>
<td>1701.0***</td>
<td>171.4***</td>
</tr>
<tr>
<td>G X Y</td>
<td>13</td>
<td>11029.7***</td>
<td>0.08</td>
<td>0.6</td>
<td>13.5***</td>
<td>173.9***</td>
<td>109.4***</td>
<td>20.9***</td>
<td></td>
</tr>
</tbody>
</table>

GY=Grain yield, M=Grain moisture, HW=Hectoliter weight, P=Protein, GL=Gluten, GI=Gluten index, S=Sedimentation and MS=Modified sedimentation.

*, ** and *** indicate the significance of 5, 1, and 0.1 %, respectively.

**Table 3. Mean values of the 1st year and 2nd year**

<table>
<thead>
<tr>
<th>Year</th>
<th>GY (kg da(^{-1}))</th>
<th>M (%)</th>
<th>HW (g)</th>
<th>P (%)</th>
<th>GL (%)</th>
<th>GI (%)</th>
<th>S (mL)</th>
<th>MS (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td>378.2 b</td>
<td>11.1</td>
<td>77.8 b</td>
<td>11.3 b</td>
<td>35.07 a</td>
<td>73.4 a</td>
<td>55.8 a</td>
<td>62.0 a</td>
</tr>
<tr>
<td>2nd year</td>
<td>453.4 a</td>
<td>11.3</td>
<td>79.1 a</td>
<td>12.05 a</td>
<td>34.37 b</td>
<td>68.2 b</td>
<td>46.8 b</td>
<td>59.1 b</td>
</tr>
</tbody>
</table>

GY=Grain yield, M=Grain moisture, HW=Hectoliter weight, P=Protein, GL=Gluten, GI=Gluten index, S=Sedimentation and MS=Modified sedimentation.

Values with the same letter in one column are not significantly different from each other.

The differences among the varieties were significant for grain yield and grain quality (Table 4). Under the conditions of the experiment, grain yield varied among the varieties ranging between 344.0 - 475.5 kg da\(^{-1}\). Romanian variety, Joseph (475.5 kg da\(^{-1}\)), had the highest grain yield whereas Turda (344.0 kg da\(^{-1}\)) and Eliva (348.2 kg da\(^{-1}\)) had the lowest. Local (control) varieties, Gönen (454.4 kg da\(^{-1}\)) and Sajittario (419.4 kg da\(^{-1}\)) were average yielders compared to the introduced varieties.
Grain moisture of the varieties was significantly different, ranging from 11.55% to 10.70%. However, the differences between years were not significant.

With respect to hectoliter weight, Boema (80.7 g) had the highest value, whereas Ardeal (75.8 g) had the lowest value, with higher values in the second year when compared with the first year. Local varieties, Gönen (76.7 g) and Saqittario (76.8 g), gave close values to each other.

**Table 4.** Grain yield and some quality characteristics of the varieties investigated over two years

<table>
<thead>
<tr>
<th>Varieties</th>
<th>GY (kg da⁻¹)</th>
<th>M (%)</th>
<th>HW (g)</th>
<th>P (%)</th>
<th>GL (%)</th>
<th>GI (%)</th>
<th>S (mL)</th>
<th>MS (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joseph</td>
<td>475.5 a</td>
<td>10.93 bcd</td>
<td>78.9 de</td>
<td>12.20 b</td>
<td>35.7 cd</td>
<td>83.5 bc</td>
<td>65.3 a</td>
<td>70.7 a</td>
</tr>
<tr>
<td>Dumbrava</td>
<td>457.3 b</td>
<td>11.45 ab</td>
<td>79.8 bc</td>
<td>11.05 ef</td>
<td>34.2 de</td>
<td>43.5 g</td>
<td>37.0 f</td>
<td>43.7 g</td>
</tr>
<tr>
<td>Trivale</td>
<td>456.5 b</td>
<td>11.45 ab</td>
<td>80.1 ab</td>
<td>11.25 def</td>
<td>33.4 ef</td>
<td>50.5 f</td>
<td>40.0 e</td>
<td>48.3 f</td>
</tr>
<tr>
<td>Gönen</td>
<td>454.4 b</td>
<td>11.22 a-d</td>
<td>76.7 hi</td>
<td>11.30 def</td>
<td>30.4 g</td>
<td>79.5 d</td>
<td>40.2 e</td>
<td>48.2 f</td>
</tr>
<tr>
<td>Apullum</td>
<td>439.0 c</td>
<td>10.70 d</td>
<td>78.4 ef</td>
<td>11.93 b</td>
<td>37.3 ab</td>
<td>63.7 e</td>
<td>58.5 b</td>
<td>66.2 bc</td>
</tr>
<tr>
<td>Boema</td>
<td>437.6 c</td>
<td>11.20 a-d</td>
<td>80.7 a</td>
<td>11.23 ef</td>
<td>32.5 f</td>
<td>81.5 cd</td>
<td>55.8 c</td>
<td>67.7 b</td>
</tr>
<tr>
<td>Saqittario</td>
<td>419.4 d</td>
<td>11.53 a</td>
<td>76.8 h</td>
<td>11.82 bc</td>
<td>32.1 f</td>
<td>85.3 b</td>
<td>50.5 d</td>
<td>57.3 e</td>
</tr>
<tr>
<td>Ardeal</td>
<td>412.4 de</td>
<td>10.87 cd</td>
<td>75.8 i</td>
<td>12.78 a</td>
<td>35.3 cd</td>
<td>79.8 d</td>
<td>56.8 bc</td>
<td>67.7 b</td>
</tr>
<tr>
<td>Gabriela</td>
<td>411.2 de</td>
<td>10.77 d</td>
<td>78.5 ef</td>
<td>10.85 f</td>
<td>34.4 de</td>
<td>83.0 bc</td>
<td>50.5 d</td>
<td>62.7 d</td>
</tr>
<tr>
<td>Fundulea</td>
<td>399.1 e</td>
<td>10.85 ed</td>
<td>78.8 de</td>
<td>11.95 b</td>
<td>35.0 ed</td>
<td>64.8 e</td>
<td>48.0 d</td>
<td>64.7 cd</td>
</tr>
<tr>
<td>Simnic</td>
<td>397.8 e</td>
<td>11.15 a-d</td>
<td>77.8 fg</td>
<td>11.73 bcd</td>
<td>38.7 a</td>
<td>48.3 f</td>
<td>48.0 d</td>
<td>55.5 e</td>
</tr>
<tr>
<td>Crina</td>
<td>369.1 f</td>
<td>11.55 a</td>
<td>79.1 cde</td>
<td>12.0 b</td>
<td>36.1 bc</td>
<td>89.8 a</td>
<td>64.2 a</td>
<td>70.5 a</td>
</tr>
<tr>
<td>Eliva</td>
<td>348.2 g</td>
<td>11.35 abc</td>
<td>79.5 bcd</td>
<td>11.37 cde</td>
<td>32.7 f</td>
<td>88.7 a</td>
<td>54.3 c</td>
<td>67.5 b</td>
</tr>
<tr>
<td>Turda</td>
<td>344.0 g</td>
<td>11.20 a-d</td>
<td>77.2 gh</td>
<td>12.13 b</td>
<td>38.5 a</td>
<td>49.0 f</td>
<td>49.5 d</td>
<td>56.8 e</td>
</tr>
</tbody>
</table>

**Mean** 415.8 11.20 78.4 11.70 34.7 70.8 51.3 60.5
C.V.% 3.18 4.52 0.95 3.69 3.77 3.13 4.47 3.44
LSD₀.₀₅ 15.29 0.58 0.87 0.50 1.52 2.57 2.65 2.41

GY=Grain yield, M=Grain moisture, HW=Hectoliter weight, P=Protein, GL=Gluten, GI=Gluten index, S=Sedimentation and MS=Modified sedimentation.
Values with the same letter in one column are not significantly different from each other.

The protein content of the varieties was higher in the second year than in the 1st year. The differences among the varieties were important. The Romanian varieties, Ardeal, had the highest grain protein content (12.78%), while Gabriela (10.85%) had the lowest grain protein content.

The genotypes used in the study gave rise to significant differences in gluten values. The Romanian varieties, Simnic (38.7%) and Turda (38.5%) had the highest gluten value, while control variety, Gönen (30.4%) had the lowest value, showing significantly lower in the 2nd year than in the 1st year.

As far as gluten index (GI) of the varieties was considered, Romanian varieties, Crina (89.8%) and Eliva (88.7%) resulted in the highest, whereas Dumbrava (43.5%) resulted in the lowest. The results of the gluten index closely resemble the results of the gluten, in other words with higher values in the first year (73.4%) compared to second year (68.2%).

For the sedimentation values (S) of the varieties between 65.3 mL (Joseph) to 37.0 mL (Dumbrava) were ascertained. The differences among the varieties were significant. Mean values of 1st year were significantly higher than those of the 2nd year.

The differences among the varieties were found to be significant for modified sedimentation (MS). The highest MS values were obtained from the varieties, Joseph (70.7 mL) and Crina (70.5 mL), while the lowest was obtained from the variety Dumbrava (43.7 mL). The mean MS value of the first year was higher than the second year.

This study showed that grain yield (GY) was negatively correlated with GL (-0.311**), S (-0.362***), and MS (-0.265*) and positively correlated with HW (0.312**), whereas there was no correlations with P, GI and M. As expected, the highest positive correlation was found between S and MS (0.857***).
Table 5. Correlations between grain yield and quality traits studied over two years.

<table>
<thead>
<tr>
<th>Traits</th>
<th>GY</th>
<th>P</th>
<th>GL</th>
<th>GI</th>
<th>S</th>
<th>MS</th>
<th>HW</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>0.120</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL</td>
<td>-0.311**</td>
<td>0.275**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI</td>
<td>-0.075</td>
<td>-0.007</td>
<td>-0.380***</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>-0.362***</td>
<td>0.096</td>
<td>0.348***</td>
<td>0.566***</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td>-0.265*</td>
<td>0.253*</td>
<td>0.240*</td>
<td>0.632***</td>
<td>0.857***</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>HW</td>
<td>0.312**</td>
<td>-0.147</td>
<td>-0.085</td>
<td>-0.113</td>
<td>-0.122</td>
<td>0.015</td>
<td>-</td>
</tr>
<tr>
<td>M</td>
<td>0.055</td>
<td>0.050</td>
<td>-0.206</td>
<td>-0.007</td>
<td>-0.143</td>
<td>-0.177</td>
<td>0.125</td>
</tr>
</tbody>
</table>

*, ** and *** indicate the significance of 5, 1, and 0.1 %, respectively.

Discussion

In this experiment, grain yield and some grain quality characteristics of the 14 bread wheat varieties 12 of which were introduced from Romania were assessed in a two year study, and a high significant variability among the varieties was determined with respect to the studied parameters. Due to genotypic variations of the genotypes included in the investigation, their responses significantly differed (5%).

Wheat grain yield is influenced by genotype, environment, planting date, crop rotation, seeding rate, fertilization, biotic-abiotic stresses, etc and their interactions. Year-to-year variations in climate gave rise to considerable variations in grain yield in the study. The distribution of rainfall over wheat growing seasons is of great importance. And also daily high temperatures and water stress in spring time shorten the grain filling period, resulting in earlier maturity of the grain, which result in lower grain yield with higher protein content. Because of the unfavorable conditions, the grain yield was lower in 1st year (378.2 kg da⁻¹) than the 2nd year (453.4 kg da⁻¹). Romanian varieties, Joseph and than Dumbrava and Trivale, had the highest grain yield compared to local varieties Gönen (454.4 kg da⁻¹) and Saqittario (419.4 kg da⁻¹).

The grain moisture of wheat is of vital importance for storage, milling industry and trade (import and export). High grain moisture results in higher microbial activity and lower dry matter which are not desirable in wheat trade. In the study, the grain moisteres of the genotypes were in average values as had been reported in earlier work [23].

Hectoliter weights of the varieties were significantly influenced by year and genotype. A direct correlation with grain yield and hectoliter weight was observed. In other words, they were higher with increasing yield. In Table 5, there was a positive correlation between grain yield and hectoliter weight (0.312**). And also mean hectoliter weight of the varieties was higher in the second year (79.1 g) than in the first year (77.8 g) when their mean grain yield was also higher (Table 3). Lopez-Bellido et al [24] and Garrido-Lestache et al [25] recorded similar results in bread wheat.

Gliadins and glutenins are major storage proteins of wheat. These are the main components of gluten, which are primarily responsible for the viscoelasticity on dough and breadmaking properties [5, 7]. As shown in Table 4, protein contents of the varieties were varied from 12.78% to 10.85%. Many reports have been published on the relationship between wheat protein content and breadmaking quality. In general, high grain protein content has been associated with good breadmaking quality. The wheat grain protein content is affected by some factors such as variety, location, crop year, temperature, rainfall, soil fertility etc. These are the most important points for the producers as well as flour technologists, millers, bakers. Previous studies also pointed out that the protein content of wheat was mainly dependent upon genotype [10, 26, 27], which was reflected in this study too with differences in gluten content among different varieties.
Generally the higher gluten content closely resembles the water absorption of flour. There are also positive correlations between protein content and gluten content. If gluten content of flour is 20% and below, it is accepted as low. If it is 27% and above, it is high [23]. In this present experiment, all wheat varieties showed high gluten content (from 30.4% to 38.7%). Unlike the statement of Elgün et al [23], this study indicated that the protein content of the varieties was higher in the second year compared to first year, whereas gluten content of the varieties was lower in the second year compared to the first year. These could be presumably due to the genotypic variations and environmental factors in the experimental conditions.

The values of the gluten index as measurement of the gluten strength of the genotypes were from 43.5% to 89.8%. The result of the first year was higher than those of the second year. It is generally accepted the values of the gluten index range 60-90% in trade for breadmaking. If its value is high, its strength is high as well [23]. Romanian varieties with higher yield compared to local varieties, Dumbrava (43.5%) and Trivale (50.5%), gave lower gluten index values mentioned above. Control cultivars had in the middle values. Romanian variety, Joseph, with high yielding resulted in 83.5% gluten index value. Vrkoc et al. [28] concluded that location was the primarily influencing factor (95%) on gluten index. In another research, Curic et al. [29] found out that optimum gluten index values were between 75 and 90% for Central European cultivars. Numerous results on gluten index of wheat have shown evidence for a great variation [25, 27, 30, 31]. According to Elgün et al. [23], the sedimentation values of flour above 36 mL are characterized as very good and also there is positive correlation between sedimentation value and baking. The sedimentation values of the varieties, in terms of characterization of the swelling capacity of gluten, had a range of 37.0-65.3 mL which was included in very good category. In general, if the gluten content of flour is higher, the sedimentation values of the flours are to be higher as well.

The modified sedimentation values of the genotypes, which allow us to understand the insect damage of Eurygaster spp. and Aelia spp. varied from 43.7 mL to 70.7 mL. The increasing insect damage results in decreased modified sedimentation values as well as flour quality. The modified sedimentation values of the varieties had higher values than those of the sedimentation values which meant that damage by Eurygaster spp. and Aelia spp. in this study was very less.

Since there are, generally, negative correlations between yield and protein content in wheat [11-13, 32], the typical negative correlations between grain yield and protein content was not found in this experiment owing to different genotypic variation and climatic variations especially in temperature and rainfall. In many investigations positive correlations were reported between grain protein content and flour quality [9, 33-35].

Many efforts have been made by plant breeders to release new bread wheat varieties with higher yielding capacity and better quality parameters. Selection of new bread wheat cultivars with higher grain yield and quality is the primary aim of breeding programs. Both grain yield and quality are affected from year to year and from location to location due to such variables, agronomic trials, fluctuations in temperature, rainfall, etc. These are typical for the Mediterranean climate. Thus, yield stability across wide environments over years has been getting more importance in respect of breeders, producers, and technologists. In Mediterranean climates including Turkey, annual wheat production and quality are influenced by mainly two climatic factors, temperature and rainfall, especially during grain filling period and maturity. The years studied were very different with respect to the climatic data (shown in Table 1) such as annual rainfall and its distribution during the growing seasons, which resulted in a greater grain yield in the second year. The results are in agreement with those of previous studies [27, 31, 36] in the same region where the investigation was carried out.
Conclusion

This two-year trial showed that differential results were obtained for grain yield and quality of the bread wheat varieties evaluated. Of the introduced materials from Romania, Joseph gave the highest grain yield compared to local (control) cultivars. Its grain quality was also found to be good for breadmaking. After Joseph variety, the introduced varieties, Dumbrava and Trivale, also gave high grain yield, but, because of their low gluten index values they were not recommended. As a result, Romanian variety, Joseph, could be grown as a new and suitable variety for the experimental region.

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