

EVALUATION OF BREAD WHEAT GENOTYPES WITH DIFFERENT PHENOLOGICAL CHARACTERS IN TERMS OF RESISTANCE TO SUNN PEST DAMAGE

Akyürek, S.¹, Başer, İ.^{2*}

¹ Ministry of Food, Agriculture and Livestock, Tekirdağ Directorate of Provincial Agriculture

² Namık Kemal University, Agricultural Faculty, Field Crops Department, Tekirdağ-Turkey

* corresponding author: ibaser@nku.edu.tr

Abstract

The research was conducted with 23 different varieties in field condition and closed area in 2010 and 2011. Twenty three bread wheat varieties were grown in open fields and closed areas in Faculty of Agriculture, University of Namık Kemal experimental area. The nifm number, sunn pest damage ratio, black point, protein ratio, moisture ratio, sedimentation rate, retarded sedimentation rate, gluten rate and index in the bread wheat varieties were examined. The highest sunn pest damage rate in the samples grown in field condition was found from Tekirdağ sample with 3,08 % and followed by Alga, Renan, Sadova, Geya and Krasnodarskaya-99 samples. The lowest damage rate was obtained from Enola and Dropia with 1,60 %; Krasunia with 1,63 %. In bread wheat samples grown in closed areas, the sunn pest damage rate increased considerably and measured between 4,93-12,75%. According to the average of two seasons, the highest sunn pest damage rate was obtained respectively from Geya, Tekirdağ, Renan and Sadova samples. The lowest damage rates were obtained from Gelibolu, KateA-1, Krasunia and Dropia samples. When the quality features were analysed, gluten, gluten index, zeleny sedimentation and retarded sedimentation values reduced substantially in comparison with values obtained outdoors. Retarded sedimentation values in all samples were at a quite low level that making the crop useless.

Key words: Sunn pest, quality, sunn pest rate, sedimentation, gluten.

Introduction

Wheat is an important agricultural crop in terms of total cultivation area and production quantity in our Thrace region and Turkey . 21.8 million ton of 35.2 million ton cereal production in 2011 year and 20.1 million ton of 33.4 million ton cereal production in 2012 in our county was obtained from wheat (TUIK 2013). The quality characters of wheat varieties are affected by various factors such as cultural practices, climate, soil conditions, the amount of seed, fertilizers, growing conditions, pests and diseases, storage conditions and seed quality.

Sunn pest is the most important factor which is showing negative effects on wheat quality and quantity in our country. The sunn pest in Southeastern Anatolia Region and Thrace

Region makes significant damage on the wheat quality and is currently making significant losses in the region. Damage rates of sunn pest in areas, which are untreated by chemical control, was reported to cause significant reduction on the wheat quantity and quality according to the instructions (Özkaya ve Özkaya 1993, Köse ve ark. 1997, Talay 1997, Hariri ve ark. 2000, Köksel ve ark. 2002, Kınacı ve Kınacı 2004, Erbaş 2005, Koçak ve Babaroğlu 2005, Olanca ve ark. 2008, Gözüaçık ve Yiğit 2011).

In the study, sunn pest damage rate, moisture rate in the grain, test weight, protein rate, gluten, gluten index, sedimentation, retarded sedimentation and black point rate in bread wheat varieties were investigated. The aim of this study was to provide valuable information

on the effects of sunn pest damage on bread wheat quality characters.

Material and Methods

Material

In the study, three bread wheat varieties having different properties as different maturity groups, long and short plant height, alternative and winter type, awned and awness, soft and hard grain structure, red and white grain structure were used as experimental

material. It was aimed to determine the effects of sunn pest damage on grain quality characters, sunn pest damage rate and grain yield in bread wheat cultivars.

Methods

In this study, 23 different bread wheat varieties was grown in the closed area and open field condition of Agricultural Faculty of Namik Kemal University, Tekirdağ, Turkey (Figure 1). Both trial was established in the same field and left a 2 meter space between trials.

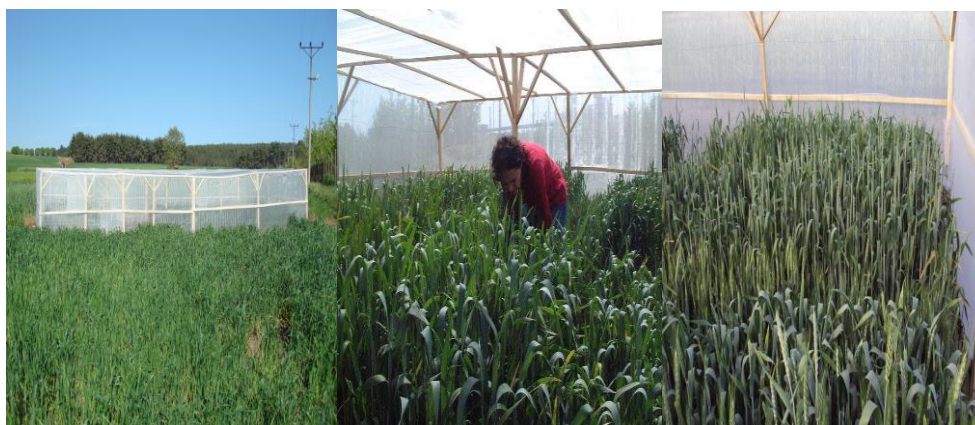


Figure 1. Plant growth and observations in experimental areas

Twenty three bread wheat cultivars in both trials were sown on 2 meter length and 2 rows with 3 replications. It was used to 500 seeds/m² in sowing. The total of 150 adult's sunn pest including 75 male and 75 female were released in the closed area in the dates of 30 April 2010 and 02. May 2011. The harvesting and threshing of all the cultivars in the trials were made separately. Sunn pest damage rate, black point rate, protein rate, moisture rate, gluten, gluten index, sedimentation and retarded sedimentation values on harvested grains of bread wheat varieties were determined. The data obtained from the study was analyzed using Tarist statistical package software according to randomized complete block design. Differences between mean values were controlled by Duncan test.

Results and Discussion

Plants Grown in the Open Field

Twenty three bread wheat cultivars were grown both in open and closed field conditions to determine the ratio of sunn pest damage. The variance analysis was made to determine effects of the sunn pest damage on moisture rate, protein rate, sedimentation, retarded sedimentation, gluten, gluten index and black point rate in grains. The differences between the all mean values except the grain moisture rate were found statistically significant at the 0.01 level. The results of Duncan test, mean values and significance groups were given in Table 1.

While the highest sunn pest damage rate was obtained from Tekirdag with 3.08, and also Alga with 2.95 %, Renan with 2.88 % and Sadova with 2.85 % were found same statistically group with Tekirdag. The lowest sunn pest damage rate between bread wheat varieties grown open field condition was obtained from Dropia and Enola with 1.60 % sunn pest damage rate. Krasunia and Kate A1 with 1.63 %, Gelibolu with 2.15% and

Guadralupe with 2.22%, Pehlivan with 2.25% and Selimiye with 2.28 % followed Selimiye. There are significant variations between bread wheat genotypes in respect to resistance of sunn pest damage rate and the the variations can be used in plant breeding (Kınacı and Kınacı 2004).

The unique properties of wheat reside primarily in its gluten-forming storage proteins. Their intrinsic viscoelastic behavior is responsible for the characteristics of different wheat-based foods and for the use of wheat gluten proteins in different food products. While gluten rate of fourteen bread wheat varieties was found 28 % or higher, the

gluten rate of nine bread wheat varieties was below 28%. Rates of sunn pest damage in the bread wheat varieties did not cause a significant decrease in gluten content. The highest gluten content was obtained from Sadova with 37%. Saraybosna variety with 36.5%, Pobeda with 36%, Sana with 33%, Geya with 32.67% and Za 75 with 32.50 % were followed this variety for gluten contents. The lowest gluten content was obtained from Krasnodak 99 and Golia with 22%, Krasunia with % 23 and Guadralupe with 23.50 % gluten content was statistically took place after this genotype.

Table 1. The average values and the significance groups of bread wheat varieties in the open field conditions during 2010-2011 years.

Varieties	Sunn pest damage rate (%)	Moisture rate (%)	Gluten value (%)	Gluten index (%)	Sedim. value (ml)	Retarded sedimentation (ml)	Black point (%)	Protein content (%)
Tekirdağ	3.08 a	11.53	28.00 g	92.00 c	53.00 f	38.50m	3.50 c	12.90 c-f
Alga	2.95 ab	11.55	30.50e	94.50 ab	55.00 de	60.00 a	2.50 de	12.50 gh
Renan	2.88 abc	11.55	29.00 f	93.50 b	46.50 k	45.50 g	3.50 c	3.05 bcd
Sadova	2.85 a-d	11.23	37.00 a	85.00 e	57.00 a	51.00 d	5.00 b	13.73 a
Geya	2.80 bcd	11.45	32.67 c	65.00 k	39.50 o	36.50 n	3.00 cd	13.25 bc
Krasnodak.99	2.80 bcd	11.80	21.50 l	87.00 d	40.83 m	35.00 o	3.50 c	11.85 kl
Nina	2.78 bcd	11.72	27.00 h	92.00 c	56.50 ab	50.00 d	2.00 e	12.60 fgh
Yubileyneya	2.73 bcd	11.52	29.00 f	95.15 a	53.00 f	60.00 a	2.50 de	12.80 d-g
Za 75	2.73 bcd	11.72	32.50 cd	87.00 d	53.50 f	38.50 m	5.00 b	13.40 ab
Saraybosna	2.68 cde	11.80	36.50 ab	80.50 g	56.00 bc	50.00 d	3.00 cd	13.70 a
Sana	2.65 def	11.52	33.00 c	67.50 i	40.00 no	21.50 s	2.50 de	13.00 b-e
Golia	2.50 efg	11.72	22.00 l	94.33 ab	34.00 r	34.00 p	3.00 cd	12.05 ik
Tina	2.50 efg	11.53	29.25 f	83.50 f	55.50 cd	46.50 f	3.00 cd	12.95 c-f
Pobeda	2.50 efg	11.70	36.00 b	77.50 h	49.83 g	31.00 r	2.50 de	13.85 a
Odeska-226	2.45 fgh	11.33	25.00 i	94.00ab	54.50 e	59.50 a	7.00 a	12.80 d-g
Selimiye	2.28 ghi	11.62	25.25 i	77.50 h	44.50 l	43.50 hi	3.00 cd	12.40 hi
Pehlivan	2.25 hi	11.75	30.33 e	82.50 f	37.83 p	43.17 i	2.50 de	12.50 gh
Guadralupe	2.22 i	11.45	23.50 k	93.50 b	40.50mn	45.00 g	3.00 cd	11.50 l
Gelibolu	2.15 i	11.47	26.50 h	87.00 d	44.00 l	39.50 l	5.50 b	12.50 gh
Kate A1	2.15 i	11.77	32.00 d	60.00 l	48.83 hi	42.00 k	3.50 c	12.83 d-g
Krasunia	1.63 k	11.67	23.00 k	95.00 a	49.50 gh	52.50 c	6.50 a	11.85 kl
Dropia	1.60 k	11.62	25.00 i	95.00 a	53.50 f	57.00 b	5.00 b	12.65 e-h
Enola	1.60 k	11.55	29.00 f	82.50 f	48.50 i	44.00 h	3.50 c	13.00 b-e
HKO	0.025		1.406	1.896	1.833	1.415	0.200	2.290

The quantity and quality of gluten are considered the most important quality parameters of wheat flour. Gluten Index

Method (GIM) is a rather new method for determining gluten quantity and quality in wheat semolina and flour. All bread wheat

varieties except Kate A1 in terms of gluten index was showed appropriate values. The obtained results indicated that the effects of sunn pest damage on gluten content and gluten index were not significant. The highest gluten index value was obtained from Yubileynaya variety with 95.15%. Krasunia and Dropia varieties with 95 % gluten index were followed this variety. Alga with 94.50 %, Golia with 94.33 %, and Odeskaya 266 with 94% gluten index was statistically took place after. While the lowest gluten index was obtained from Kate A1 with 60%, Geya with 65 % and Sana with 67% gluten index were ranked after from this variety.

Sedimentation test was considered in comparison with other quality tests, it is a relatively low-cost, less time-consuming test that requires low manpower, is inexpensive and requires no elaborate laboratory equipment. It has proved to be a reliable, highly reproducible quality test that generally gives a good indication of the end-use quality of wheat (Blackman and Gill, 1980 and Carter et al., 1999).

The variations for sedimentation values of bread wheat varieties were found significant levels. Sedimentation value should be 28 ml or more. Zeleny sedimentation value of bread wheat varieties was ranged from 34-57 ml. When bread wheat varieties are compared for this quality character, the highest value in the varieties was obtained from Sadova variety with 57 ml, Nina with 56.50 %, Saraybosna with 56.00% and Tina with 55.50% sedimentation value were followed by this variety. The values obtained indicated that the sunn pest damage rates which are not high level are not significant impact on the sedimentation value. The lowest sunn pest damage rate was obtained from Golia with 34 %, Pehlivan with 37.83% and Geya with 39.50%.

Retarded sedimentation value in bread wheat genotypes was decreased significantly according to sedimentation values in some varieties. This reduction showed that sunn pest damage was reduced significantly by retarded

sedimentation value. When bread wheat varieties are compared for retarded sedimentation value, the highest value was obtained from Alga and Yubileynaya varieties with 60 ml value. Odeskaya 226 with 59.50 ml and Dropia with 57 ml were found second place for sunn pest damage. The lowest retarded sedimentation values were observed from Sana with 21.50 ml, Pobeda with 31ml and Golia with 34 ml. The retarded sedimentation value in the majority of examined varieties was found under the sedimentation value. According to the results obtained, sunn pest damage had significant negative effect on retarded sedimentation value of bread wheat varieties.

The black point rate in grain of bread wheat varieties was ranged from 2.0-7.0 %. While the highest black point rate was found from Odeska 226 with 7%, Krasunia with % 6.5 and Dropia and Za 75, Pobeda with 5% were statistically second place.

The protein content in bread wheat should be between 11-13%. The protein content of bread wheat varieties in the study was found within the desirable limits. The highest protein content among bread wheat varieties was obtained from Pobeda with 13.85%. Sadova with 13.73 %, Saraybosna with 13.70 % were followed this variety. While the lowest protein rate was obtained from Guadraluppe with % 11.50, protein content in Krasunia and Krasnadorskaya with 11.85 % was ranked later. The obtained results indicate that the effect of sunn pest damage on protein content was statistically insignificant.

Plants Grown in the Closed Area in the Field Conditions

The combined variance analysis was made by data obtained from twenty three bread wheat varieties grown in closed areas in field conditions in both years. Differences between the mean values were found statistically significant at the 0.01 level and the results of the significance test (DUNCAN) are given in Table 2.

Sunn pest damage rates were found quite high level and bread wheat varieties showed different responses to sunn pest damage. Sunn pest damage rate in bread wheat varieties was changed between 4.93-12.75 %. Sunn pest

damage higher than 10 % makes negative effect on the quality of wheat flour. It has been reported that production of bread from flour damaged by % 20 or higher sunn pest is impossible (Hariri et al., 2000).

Table 2. Mean values and significance groups of bread wheat varieties grown in the closed area in 2010-2011

Varieties	Sunn pest damage rate %	moisture rate %	Gluten value	Gluten index	Sedim. value (ml)	Retarded sedim. value (ml)	Black point %	Protein content %
Geya	12.75 a	11.60	21,50 i	40,00 h	21,50m	5,00 k	5,03 b	11,57 ik
Tekirdağ	12.75 a	11.75	25,50 e	70,00 b	28,50 h	5,17 k	5,00 bc	12,40 c
Saraybosna	12.30 ab	12.20	25,50 e	70,00 b	28,50 h	5,50 ik	3,50 cd	12,40 c
Sana	12.00 ab	11.85	29,00 b	45,00 fgh	29,50 g	9,83 c	3,33 cde	12,32 cd
Za-75	11.50 abc	11.60	26,17 e	40,00 h	24,50 l	6,67 g	4,00 cd	12,31cd
Krasnodak.99	11.25 a-d	11.70	25,50 e	50,00 def	26,50 k	6,50 gh	2,50 ef	12,07 fg
Enola	11.10 b-e	11.70	28,50 bc	44,00 fgh	31,50 e	7,00 fg	4,02 c	12,35 cd
Odeskaya-226	10.75 b-f	11.50	23,00 h	48,33 efg	30,50 f	7,00 fg	8,52 a	12,28 cd
Guadralupe	10.25 c-g	11.50	19,00 k	50,00 def	24,00 l	5,00 k	3,00 de	11,27 l
Renan	10.10 c-h	11.40	23,50 gh	70,00 b	34,50 b	11,50 b	3,50cd	12,27 cd
Yubileyneya	9.75 d-i	11.70	25,50 e	90,00 a	30,50 f	5,17 k	3,00 de	11,92 h
Nina	9.60 e-ı	11.65	23,00 h	60,00 c	30,50 f	5,00 k	2,00 f	11,87 h
Popeda	9.40 f-i	11.75	24,00 fg	55,00 cd	24,00 l	6,50 gh	2,50 ef	11,63 i
Sadova	9.40 f-i	11.80	28,00 cd	45,00 fgh	27,00 ik	10,50 c	2,00 f	11,93 gh
Tina	9.10 g-k	11.55	24,50 f	72,50 b	30,00 fg	8,00 de	2,00 f	12,22 de
Alga	8.75 g-k	11.50	29,00 b	42,50 gh	33,50 c	5,50 ik	2,00 f	12,68 b
Dropia	8.600h-k	11.65	24,50 f	45,00 fgh	30,50 f	7,50 ef	3,50 cd	11,55 ik
Krasunya	8.517iik	11.40	23,00 h	75,00 b	38,50 a	12,50 a	6,00 b	12,08 ef
Selimiye	8.250iik	11.70	23,17 h	52,50 de	31,83 e	8,00 de	3,50 cd	11,65 i
Pehlivan	8.000ik	11.40	27,67 d	45,00 fgh	29,50 g	5,00 k	3,00 de	12,28 cd
Golia	7.850k	11.35	30,18 a	73,00 b	32,67 d	9,83 c	2,50 ef	13,40 a
Katea-1	7.750k	11.40	23,50 gh	45,00 fgh	27,50 i	6,00 hi	3,50 cd	11,47 k
Gelibolu	4.933l	11.45	25,50 e	70,00 b	32,00 de	12,00 ab	5,00 bc	11,90 h
HKO	1.167		2.486	23.567	1.667	1.899	0.877	0.036

Sedimentation values among bread wheat varieties were showed a significant variation and ranged from 21.50-38.50 ml. The sedimentation values obtained from the closed area were relatively lower than varieties grown in the open area. These results showed that sunn pest damage rate, which was above a certain level, was decreased significant level the sedimentation values. The highest sedimentation value among bread wheat varieties was obtained from Krasunia with 38.50 % and Renan with 34,5 %. However, the lowest sedimentation value was observed from Geya with 21.50 %, Pobeda with 24.00 %, Za

75 with 24.50, which were placed after this variety.

The retarded sedimentation values of bread wheat varieties grown in the closed area were very low. The retarded sedimentation values were changed to 5.0-12.50 ml. While Krasunia variety with 12.50 ml sedimentation value had the highest retarded sedimentation value, Gelibolu with 12.00 %, Guadralupe with 11.50 ml and Sadova with 10.50 % was took second place. Retarded sedimentation values were found low than 5 ml in many varieties. When sunn pest damage rate in bread wheat varieties is % 8 or the higher,

consumption of grains as food will be quite low.

Sunn pest damage rates in the wheat varieties grown in the closed area were found higher than the varieties grown in the open area in field conditions. According to the two-year average values, Geya variety with 12.75 % among bread wheat varieties was found the first line for sunn pest damage rate. Tekirdağ with 12.75 %, Saraybosna with 12.30 % and Sana with 12.00% were ranked same statistical group with this variety. The lowest sunn pest damage rate among bread wheat varieties grown in the closed area was obtained from Gelibolu with 4.93 %, Kate A1 with 7.75 %, Golia with 7.85 % and Pehlivan with 8.0 %.

Gluten proteins promote formation of a strong and visco-elastic dough structure, and this also affects kneading extension and development of dough (Wade, 1970; Finney *et al.*, 1978; Boyacıoğlu, 1994). Gluten content of bread wheat varieties grown in the closed area was quite lower than the varieties grown in the open area. This results indicated that sunn pest damage ratio, which is above a certain value, are affected negatively on gluten content. Gluten content in bread wheat varieties was ranged between 19.00-30.18%. The highest value was obtained from Golia variety with 30.18%. Sana and Alga varieties with 29.00% gluten content were ranked after this variety. Gluten content in bread wheat varieties grown in the closed area was decreased significantly and the lowest values were obtained from Guadruplepe with 19.00 %, Geya with 21.50 %, Odeskaya 226, Krasunia and Selimiye with 23.00 %.

Gluten index in bread wheat should be between 60-90%. While the eight varieties among the examined varieties had gluten index between these values, the fifteen bread wheat varieties had lower values than these values. When gluten index values in bread wheat varieties are compared, Yubileynaya variety had the highest gluten index value with 90 %. Krasunia with 75.0%, Golia with 72.50 %, Gelibolu, Renan, Tekirdağ ve Saraybosna with 70 % were followed this variety. The lowest

gluten index value was observed from Geya and Za 75 variety with 40 %. While gluten index values in some bread wheat varieties were changed between the desirable values, gluten index values in the most of bread wheat varieties were low in this study. According to obtained results, high sunn pest damage ratio had negative effects on gluten index values.

The black point rates on grains of bread wheat varieties were found as high as 2-8%. The highest black point rate in grains was observed from Odeskaya 226 with 8.52%. Krasunia with 6.0%, Geya with 5.03%, Gelibolu and Tekirdağ with 5.0% were followed this variety.

The highest protein content in bread wheat varieties grown in the closed area was obtained from Golia with 13.40 %, Alga with 12.68 %. Tekirdağ and Saraybosna with 12.40 % protein content were followed these varieties. The lowest protein content was found from Guadruplepe variety with 11.47 %. Kate A1 with 11.47%, Dropia with 11.55 % and Geya with 11.57 % were ranked after this variety. The suitable protein content in bread wheat is between 11-13% for food products. Protein content of bread wheat varieties damaged by sunn pest was not show a significant change. It showed that direct effect of sunn pest on the protein content is statistically insignificant.

According to the obtained results, the effect of increased sunn pest damage rates on quality characters of bread wheat varieties grown in the closed area was found negative and statistically significant. Gluten content, gluten index, sedimentation and retarded sedimentation values were the most affected characters by sunn pest damage. When sunn pest damage rates in bread wheat varieties grown in the open field conditions compared with bread wheat varieties grown in the closed area, resistance rates of bread wheat varieties to sunn pest damage was not show differences. The highest values for resistance to sunn pest damage in both experiment were obtained from Gelibolu, Dropia, Krasunia and Kate A1. The most varieties affected by sunn pest

damage were Tekirdag, Geya and Krasnadorska 99. The obtained data demonstrated that genotypic structure of varieties in terms of resistance to sunn pest damage in wheat breeding is highly important. Bread wheat varieties, which are show high resistance to sunn pest damage, are developed in a short time by well organized wheat breeding program.

References

1. Boyacıoğlu, M.H., 1994. Un ve ekmeğin depolanması ve paketlenmesi. *Un Mamülleri Dünyası*., 3: 24.
 2. Erbaş M (2005). Süne, *Eurygaster* spp., (Hemiptera: Scutelleridae) Böceklerinin Buğdaylara Verdikleri Tek. Zararlar ve Zararların Azaltılma Çalışmaları. *Unlu Mam. Tek.*, 14(69):62-64, 66-68, 70-82.
 3. Finney, K.F., B.L. Jones and M.D., Snogren, 1978. Functional (Breadmaking) properties of wheat protein fractions obtained by ultracentrifugation. *Cereal Chem.*, 59: 449-54
 4. Gözüaçık C, Yiğit A (2011). Süne, *Eurygaster integriceps* Put. Zararının Bazı Buğday Çeşitlerinde Kalite Özelliklerine Etkileri. Türkiye IV. Bitki Koruma Kongresi 28-30 Haziran 2011, Kahramanmaraş.
 5. Hariri G, Williams PC, El-Haramin FJ (2000). Influence of Pentatomid Insects on the Physical Dough Properties and Two-Layered Flat Bread Baking Quality of Syrian Wheat. *Journal of Cereal Science*, 31:111-118.
 6. Kınacı E, Kınacı G (2004). Quality and yield losses due to sunn pest (*Hemiptera: Scutelleridae*) in different wheat types in Turkey, *Fields Crops Research* 89, 187-195.
 7. Koçak E. ve Babaroğlu N. (2005). Orta Anadolu bölgesi kışlaklarındaki *Eurygaster* (Heteroptera: Scutelleridae) türleri. 29 (4): 301-307.
 8. Köksel H, Sivri D (2002). Süne-Kımlı Enzimlerinin Çeşitli Özellikleri ve Gluten Proteinleri Üzerine Etkileri. *Hububat 2002 Hububat Ürünleri Tekn. Kong. ve Sergisi Bildiri Kitabı*, s.49-56.
 9. Köse E, Ünal SS, Olçay M, Kınacı G (1997). Değişik Buğday Çeşitlerinde Süne Zararının Unun Reolojik Özelliklerine Etkisi. *Selçuk Üniversitesi Türkiye 2. Değirmencilik Sanayii ve Teknolojisi Sempozyumu Bildiri Kitabı*, Konya, s.185-196.
 10. Olanca B, Köroğlu D, Sivri Özay D, Köksel H, Dönmez,E, Sanal T (2008). The Extent of Gluten Degradation in Bread Wheat Cultivars due to Bug (*Eurygaster* spp.) Proteases by SE-HPLC (H. KÖKSEL, U. UYGUN, and A. BAŞMAN editörler). *Bosphorus 2008 ICC International Conference*, ISBN 978-9944-0519-0-3, İstanbul, p.140.
 11. Özkaya H, Özkaya B (1993). Buğday Kalitesi Süne ve Kımlı'nın Önemi. *Un Mam. Dün.*,2 (3):20-25.
 12. Talay M (1997). Ekmek Bilimi ve Teknolojisi. *Ray Filmcilik Matbaacılık*, İstanbul, 120s.
- TUİK (2013). Türkiye İstatistik Kurumu.
<http://tuikapp.tuik.gov.tr/bitkiselapp/bitkisel.zul> Erişim Tarihi: 24.07.2013