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INVESTIGATION ON THE YIELD AND GRAIN QUALITY OF BREAD WHEAT VARIETIES IN SOUTHEAST BULGARIA

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Abstract

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During the period of 2008-2011 in south-east Bulgaria a field experiment was researched. The varieties bread wheat Sadovo 1, Aglika , Enola and Milena were studied. The experiment was applied in block design with 4 replications and 15 m^2 plot size, after predecessor sunflower. The growing of plants was performed in compliance with the standard technology.

The aim of the study was to establish the grain yield and quality of four bread wheat varieties, grown in Southeast Bulgaria. The analysis of the results showed that the highest grain yield was obtained from Enola variety – 6057 kg ha^{-1}, followed by Aglika – 5777 kg ha^{-1} and the lowest one – from Sadovo1 variety 5060 kg ha^{-1}. The test weight of the investigated varieties is close values; wich indicates that it is in effect – largely on the weather conditions of the year, rather than the variety. The thousand kernel (grain) weight of Aglika variety were highest - 49.7g and lowest of Sadovo 1 – 43.4g. The grain of variety Milena produce was highest vitreousness – 81.7 % and variety Aglika lowest –66.5 %. Milena variety show the best values (29.1 %, 10.4 % and 5.7 mm) of the investigated technological properties of the grain (wet gluten, dry gluten and relaxation of the gluten) among the tested varieties winter wheat.

Key words: bread wheat, grain yield, test weight, thousand grain weight, vitreousness, gluten

Intoduction

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 Bulgaria grown in 11 315 647 da area producing 4 094 597 tons production and 361.9 kg da^{-1} grain yield in 2010. 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. The developments of high grain yield potential with good quality and resistance to biotic and abiotic stress factors and which respond to improved agricultural practices are the main achievements for bread wheat breeding programmes (Delibaltova and Ivanova, 2006; Tsenov et al., 2004).

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 (Delibaltova and Kirchev, 2010; Tayyar, 2010).

The gluten content of wheat is a critical factor in breadmaking and high gluten content of wheat is associated with good breadmaking characteristics. It is genetically controlled but may vary widely depending upon the variety, location, climatic conditions, soil fertility, etc and the complex interactions between these factors. In general, high gluten flours give rise to better results since they have a high loaf volume potential with higher water absorption. Genotype-by-environment interactions and the negative correlation between grain yield and grain gluten content of wheat had been established in different studies (Williams, et al., 2008). If a genotype has a high stability and shows low interactions with the environment is desirable in plant breeding.

The right choice of the bread wheat varieties and the proper regional distribution, as well as their growing by strictly following the agrotechnical practices, are of vital importance for the yield amounts and the quality of the produce obtained (Delibaltova et al., 2009; Ivanova et al., 2007; Nankova and Penchev, 2006; Sevov et al., 2010).

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That necessitates the constant introduction of new varieties that are the most suitable and efficient for the separate microregions of the country.

The aim of the study was to establish the grain yield and quality of four Bulgarian bread wheat varieties, grown in grown in Southeast Bulgaria.

Material and Methods

Research activities were conducted in the period of 2008-2010 at the experimental field of the village of Jhrebino, Southeast Bulgaria. The experiment was performed on carbonate vertisols soil type whit sandy-clayed texture, by means of a block method with four repetitions; experimental field area - 15 m^2, after the predecessor sunflower. The contents of the basic nutrient elements in the 0-20 cm layer were as follows: N-26.6 mg/1000 g, P_2O_5-11.2 mg/100 g, K_2O-38.1 mg/100 g, humus-3.31 %. The following varieties were tested Sadovo1, Aglika, Enola and Milena. All the stages of the established technology for wheat growing were followed.

Soil tillage included single disking (10-12 cm) after harvesting of the previous crop, and double disking after the main fertilization. The area was treated by $N_{120}P_{80}$ and the whole quantity of the phosphorous fertilizer and 1/3 of the nitrogenous fertilizer were applied before main soil tillage. The remaining amount from the nitrogen norm was applied before the beginning of permanent spring vegetation. Triple super phosphate and ammonia nitrate were used. Sowing was completed within the agrotechnical term optimal for this region at sowing norm 550 germinating seeds/m^2. Control of weeds, diseases and pests was done with suitable pesticides when necessary. Harvesting was done at full maturity. The grain yield is determined with standard grain moisture of 13%.

The indices grain yield (kg ha^{-1}); test weight (kg); thousand kernel (grain) weight (g), vitreousness (%); relaxation of gluten (mm); wet and dry gluten content (%) and were determined.

For determining the quantity dependence between the studied indicators, the experimental data was processed according to the Anova Method of dispersion analysis, and the differences between the variants were determined by means of the Dunkan's Multiple Range Test (Dunkan, 1955).

The period of the research (2008-2011) is characterized with variety of temperature and rainfall conditions, which enables to evaluate the reaction of the studied varieties in accordance with their yields and quality characteristics under different climatic conditions (Figure 1).

Rainfalls in autumn and during the critical spring period are decisive for the development of the wheat plants. The mean annual precipitation sums during October – March, which formed the autumn-and-winter moisture reserves in soil during the experimental years 2008-2009, 2009-2010 and 2010-2011 were higher with 9.0, 62.2 and 74.2 mm, respectively, than the mean sums of the long - term period. During April-May when plants were at stages booting and heading, the mean annual precipitation sum in 2009 and 2010 was lower than the mean long - term value, while in 2011 this sum was higher with 8.6 mm. In June (during grain filling-maturation) rainfalls in harvest year 2009 was lower with 8.2 mm, in comparison to the long - term period, while in 2010 and 2011 they were with 23.1 and 5.5 mm , respectively higher.

The most favorable for plant growth and development was the third experimental year (2010-2011), followed by the second (2009-2010), and unfavorable was the first year (2008-2009), of the experiment, having an effect on yield and grain quality of bread wheat.

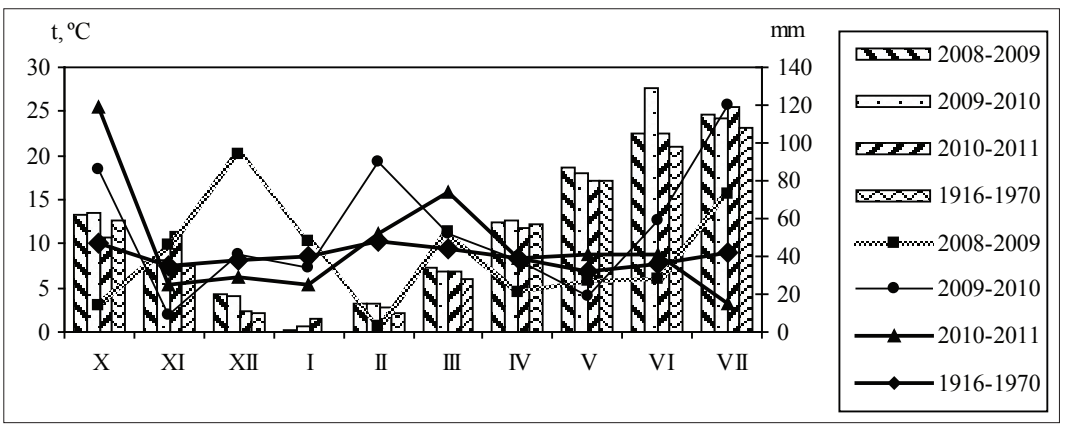

Fig. 1. Temperature and rainfall distribution during the period 2008-2011

Results and Discussion

The results obtained were presented in Table 1 and they showed that both by years and in average for the experimental period variety Enola surpassed in grain yield all the other varieties included in the study.

The highest grain yields were obtained in the favorable for wheat 2011 when the temperature values and the precipitation sum fully met the plant requirements for warmth and moisture throughout the whole vegetation period. The yields obtained reached up to 6650 kg/ha in variety Enola. Referring to grain yield that variety surpassed the varieties Aglika, Milena and Sadovo 1 by 8.8 %, 16.7 %, and 23.1 %, respectively, the differences being statistically significant.

In the second experimental year (2010) the grain yields obtained varied from 5180 kg/ha to 6030 kg/ha, i.e. they were by 6.5 % lower in average in comparison with 2011year. Mathematical processing of data showed that varieties Aglika and Milena significantly fell behind Enola by 130 and 730 kg/ha, respectively. The lowest yields were realized by variety Sadovo 1 – 5180 kg/ha.

In the first experimental year of the study, the meteorological conditions during the variety vegetation were unfavorable and the plants were not able to attain their biological potential. The grain yields obtained were within the limits of 4600 to 5490 kg/ha. Statistically proven, the lowest ones were those of variety Sadovo 1 and the highest – Enola.

During the period of study (2008-2011), Enola variety realized the yield of 6057 kg/ha in average and it surpassed the varieties Aglika, Milena and Sadovo 1 by 4.8 %, 14.3 %, and 19.7 %, respectively.

The results from the multifactor analysis of variances showed the independent effect of the investigated factors, as well as their interaction (Table 2). Years with their climatic conditions had highest statistic influence on the seeds yield – η 98, followed by variety - η 88.

Interaction - Years x Variety - η 74 was also significant for grain yield.

The test weight of the investigated varieties is close values; which indicates that it is in effect – largely on the weather conditions of the year, rather than the variety (Table 3).

The highest values of the characteristic test weight were established in the last experimental year (2011), in the tested varieties varied from 79.0 kg (Sadovo 1) to 82.0 kg (Aglika). The lowest values of the characteristic test weight were established in the first year of the study (2009), from 77.2 to 78.0 kg. It showed that the low amount of rainfall during the vegetation has a negative influence on grain formation.

In average, during the three-year period of study, the test weight of all investigated varieties varied from 78.3 kg of the variety Sadovo 1 to 79.8 kg of Enola variety. It showed that the drain is considered good for flour producing.

The thousand kernel (grain) weight is one of the important indirect indicators, characterizing grain properties, its technological value as well as its quality regarding using it as sowing material. This indicator characterized its filling up as well as its thickness.

The thousand kernel (grain) weight changes under the influence of weather conditions during the year.

In the most favorable for wheat year (2011) the values of this characteristic were within the limits of 45.9 to 53.0 g. Statistically proven, the lowest ones were those of variety Sa-

Table 1
Grain yield, kg/ha

Variety	Years of study			Average for the period kg/ha
	2008-2009, kg/ha	2009-2010, kg/ha	2010-2011, kg/ha	
Sadovo 1	4600 [a]	5180 [a]	5400 [a]	5060
Aglika	5320 [c]	5900 [c]	6110 [c]	5777
Enola	5490 [d]	6030 [d]	6650 [d]	6057
Milena	4900 [b]	5300 [b]	5700 [b]	5300
LSD 5 %	171.0	69.3	77.6	

Table 2
Analysis of variance for grain yield for the period 2008-2011

Source of Variation	Sum of Square	DF	Mean Square	Sig of F	η^2
Variety	7384116.67	3	2461372.2	.000	88
Years	6422879.17	2	3211439.6	.000	98
2- Way Interactions	326220.83	6	54370.14	.000	74
Residual	116000.00	36	3222.22		

dovo 1 and the highest – of Aglika. The results of the varieties Enola and Milena had quite close values and they were statistically insignificant.

In the second experimental year (2010) the values of thousand-kernel weight varied from 43.0 to 49.5 g, i.e. they were by 8.1 % lower in average in comparison with 2011 year. Mathematical processing of data showed that variety Aglika significantly fell behind Enola and Milena 6.0 and 7.6 %. The lowest the values of this characteristic were realized by variety Sadovo 1 – 43.0 g.

In the unfavourable (dry) for wheat year (2009) the thousand kernel weight in the investigated varieties was from 41.2 to 46.7 g, i.e. they were by 12.5 and 5.2 % lower in average in comparison with 2011 and 2010 years.

Out of all the investigated varieties smallest the thousand kernel weight, in average for the three years, was established in variety Sadovo 1 – 43.4 g and the biggest - formed by Aglika – 49.7 g . The highest values of the characteristic vitreousness were reported in Milena variety – 84.6, 77.5 and 83.0 % respectively for 2009, 2010 and 2011. The lowest - were realized by Aglika variety - 69.3, 63.0 and 67.1 % respectively for the first, second and third years. The differences among varieties were statistically significant.

During the period of study (2009-2011), Milena variety realized vitreousness of 81.7 % in average and it surpassed the varieties Enola, Sadovo 1 and Aglika by 4.5, 10.8 and 22.9 %, respectively.

Meteorological conditions exert certain influence on the amount of gluten, thus the amount of gluten is the highest during the first and the third years of the experiment, and during the two years due to the dry weather during the period of filling of the grain (Table 4).

It has been established that during the drier years protein content of grain is higher, hence it follows that gluten is directly related to protein content as it itself is a protein component.

During 2010, which is characterized with good waterfall supply during the period of formation process of the grain, the amount of gluten is the lowest - from 20.0 % (Aglika) to 27.2 % (Milena) and from 5.9 % (Aglika) to 8.2 % (Milena) of the wet and dry gluten content respectively.

In the first experimental year (2009), the wet and dry gluten content is the highest - varied from 25.2 to 32.1 % and 7.6 to 12.0 % in the studied varieties. It was statistically proven that Milena variety surpassed the varieties Enola, Aglika and Sadovo 1 by 14.0, 26.8 and 13.3 % respectively.

The following indices show the influence of the variety on the amount of wet gluten. On the average for the three years of the experiment, the highest is the formation

Table 3
Physical properties of the grain

Variety	Test weight, kg				Thousand kernel (grain) weight, g				Vitreousness, %			
	Years of study			Average	Years of study			Average	Years of study			Average
	2008-2009	2009-2010	2010-2011		2008-2009	2009-2010	2010-2011		2008-2009	2009-2010	2010-2011	
Sadovol	77.2 ^{a}	78.6 ^{a}	79.0 ^{a}	78,3	41,2 ^{a}	43,0 ^{a}	45,9 ^{a}	43,4	76.5 ^{b}	70.2 ^{b}	75.0 ^{b}	73.9
Aglika	78.0 ^{b}	79.0 ^{ab}	82.0 ^{b}	79,7	46,7 ^{c}	49,5 ^{c}	53,0 ^{c}	49,7	69.3 ^{a}	63.0 ^{a}	67.1 ^{a}	66.5
Enola	77.8 ^{a}	80.5 ^{ab}	81,0 ^{ab}	79,8	45,0 ^{b}	46,7 ^{b}	50,1 ^{b}	47,3	81.2 ^{c}	74.6 ^{c}	78.8 ^{c}	78.2
Milena	76.2 ^{ab}	79.0 ^{a}	81.0 ^{ab}	78,7	44,3 ^{b}	46,0 ^{b}	51,0 ^{b}	47,1	84.6 ^{d}	77.5 ^{d}	83.0 ^{d}	81.7
LSD $_{5\%}$	*3.10*	*1.50*	*2.90*		*1,50*	*2,80*	*1,79*					

Table 4
Technological properties of the grain

Variety	Wet gluten, %				Dry gluten, %				Relaxation of the gluten, mm			
	Years of study			Average	Years of study			Average	Years of study			Average
	2008-2009	2009-2010	2010-2011		2008-2009	2009-2010	2010-2011		2008-2009	2009-2010	2010-2011	
Sadovol	28.3 ^{b}	22.0 ^{a}	25.2 ^{b}	25.2	10.6 ^{b}	7.1 ^{b}	8.0 ^{b}	8.6	6.4 ^{b}	7.3 ^{b}	7.0 ^{b}	6.9
Aglika	25.2 ^{a}	20.0 ^{a}	22.4 ^{a}	22.5	9.5 ^{a}	5.9 ^{a}	6.5 ^{a}	7.3	7.0 ^{c}	8.5 ^{c}	7.4 ^{b}	7.6
Enola	28.0 ^{b}	25.0 ^{b}	26.0 ^{b}	26.3	10.4 ^{b}	7.5 ^{b}	8.8 ^{b}	8.9	6.4 ^{b}	8.1 ^{c}	7.8 ^{b}	7.4
Milena	32.1 ^{c}	27.2 ^{c}	28.0 ^{c}	29.1	12.0 ^{c}	8.2 ^{c}	11.1 ^{c}	10.4	5.0 ^{a}	6.6 ^{a}	5.5 ^{a}	5.7
LSD $_{5\%}$	*2.10*	*1.18*	*1.70*		*1.28*	*1.20*	*2.30*		*0.81*	*0.70*	*1.95*	

of wet and dry gluten of Milena variety – 29.1 % and 10.4 %, while the lowest is of Aglika variety – 22.5 % and 7.3 %. The results obtained were statistically significant.

In addition to amount of gluten, its quality is determinative too for the bread producing and baking properties of certain grain yield. The main property determinative for the quality of gluten is its relaxation.

In this study the relaxation of gluten of the four varieties during the three years of the experiment is according to standard, i.e. it is lower than the maximum of 10 mm over which standard the grain is no good for bread making.

The lowest relaxation of the gluten were obtained in the first year of the study (2009) due to the dry weather during the period of filling of the grain and varied from 5.0 to 7.0 mm in the investigated varieties.

The highest relaxation of the gluten were obtained in the second experimental year (2010) which is characterized with good waterfall supply during the period of formation process of the grain and the values of this characteristic varied from 6.6 to 8.5 mm.

During the period of study (2009-2011) the studied varieties form gluten of different quality, the lowest is relaxation of Milena variety -5.7 mm while the highest is of Aglika variety – 7.6 mm.

Conclusions

Under the conditions of Southeast Bulgaria, the highest yield was obtained from Enola variety – 6057 kg ha^{-1}, followed by Aglika – 5777 kg ha^{-1} and the lowest one – from Sadovo1 variety 5060 kg ha^{-1}.

The test weight of the investigated varieties is close values; wich indicates that it is in effect – largely on the weather conditions of the year, rather than the variety.

The thousand kernel (grain) weight of Aglika variety were highest - 49.7g and lowest of Sadovo 1 – 43.4g.

The grain of variety Milena produce was highest vitreousness – 81.7 % and variety Aglika lowest –66.5 %.

Milena variety show the best values (29.1 %, 10.4 % and 5.7 mm) of the investigated technological properties of the grain (wet gluten, dry gluten and relaxation of the gluten) among the tested varieties winter wheat.

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