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IMPACT OF CLIMATE CHANGE ON QUALITY PARAMETERS OF DURUM WHEAT

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Abstract:
Durum wheat represents the most suitable raw material for the production of pasta. The high level of quality standard uniformity of different varieties of durum wheat is of great importance for pasta making industry. The genotypes quality is subject to changes to occur as a consequence of changed climate conditions. Genetic material used in this research includes fourteen genotypes of durum wheat grown on the same locality during two production years . The most important quality factors include a high content of protein, hectoliter mass, 1000 - grain weight, hardness, kernel vitreousness and sodium dodecyl sulphate sedimentation. The aim of this work is quality parameters assessment of various durum wheat genotypes grown during two productions years, examination of the relation between quality parameters, and of the climatic factors influence on the technological quality of durum wheat.

Keywords: *Climatic change, Durum wheat, Technological quality*

Introduction

Agriculture in the world and in Serbia is increasingly facing challenges caused by climate change. Global climate change is directly or indirectly attributed to human activities. The fight against these changes should be a priority with the application of adequate agricultural measures aimed at mitigating and overcoming the harmful effects caused by climate change [1]. One of the solutions for global warming is the creation of genotypes resistant to climate change is one of the most important tasks of breeders. Serbia has achieved significant progress by passing the Law on Climate Change ("Official Gazette of RS", No. 26/2021) [2].

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Overview of past climate changes in Serbia, as well as climate projections for the 21st century are in the First National Communication of the Republic of Serbia [3]. Projections according to regional climate models predict that will increase the average annual temperature level of 2,4 °C by the end of this century up to 2,8 °C according to the optimistic scenario (A1B1), that is, from 3,4 °C to 3,8 °C according to pessimistic scenario (A2) (Table 1.).

Table 1: *Change in temperature by season.*

	A1B1 2001-2030	**A1B1 2071-2100**	**A2 2011-2071**
Dec/Jan/Feb	0,5-0,1	1,8-2,2	2,6-3,6
Mar/Apr/May	1-1,2	2,4-2,8	3,6-4
June/July/Aug	1,2-1,4	3,2-3,6	4,2-4,6
Sep/Oct/Nov	0,5-0,9	1,8-2,2	2,6-3,2
Year	0,8-1,1	2,4-2,8	3,4-3,8

Source: MŽSPP, 2010: Initial National Communication of the Republic of Serbia under the United

According to the same model, the precipitation trend is expected to be negative until the end of this century. According to scenario A1B1 precipitation will decrease in the interval from -15% to 0% on an annual level, and according to scenario A2, it will decrease from -15% to -5% on an annual level (Table 2.).

Table 2: *Change in precipitation in % by season.*

	A1B1 2001-2030	**A1B1 2071-2100**	**A2 2011-2071**
Dec/Jan/Feb	-10-5	-20-0	-15-5
Mar/Apr/May	15-15	-15-10	-30-0
June/July/Aug	-5-30	-30-5	-50-10
Sep/Oct/Nov	-10-20	-30-5	-30-10
Year	-5-10	-15-0	-15-5

Source: MŽSPP, 2010: Initial National Communication of the Republic of Serbia under the United

It was found that climatic conditions influence the technological quality indicators of wheat, such as hectoliter mass, grain hardness [4], protein content [5], sodium dodecyl sulfate SDS sedimentation and vitreousness [6]. A high level of uniformity in the quality of durum wheat varieties is extremely important for the pasta industry. The

quality of durum wheat genotypes is subject to changes that occur in response to changing climatic conditions.

1. Materials and methods

The genetic material used in this research included 14 genotypes of durum wheat, winter and facultative type, obtained from the Gene Bank of the Maize Institute in Zemun Polje. The durum wheat lines were produced in the same locality (Zemun Polje (ZP) (44°52′ N; 20°19′ E) and 88 m above sea level, during two production years (2012 and 2013).

All tests were carried out within the accredited laboratories of the Scientific Institute for Food Technologies FINS in Novi Sad. Chemical-technological analyzes were performed on each sample of durum wheat and included the following tests:

Hectolitre mass, protein content, moisture content of durum wheat, moisture content of durum semolina were determined using a NIR device ((Infratec 1241 Grain Analyzer (Foss Analytical AB, Hillerod, Denmark)). Sodium dodecyl sulfate (SDS) sedimentation of durum semolina was determined according to ICC method 151 [7]. To determine the mass of 1000 grains, a grain counting machine with a photo cell was used, and the mass was measured on an analytical balance.

Visual evaluation of the appearance of the grain cross-section, i.e. the appearance of the endosperm structure, was determined by counting 50 grains twice and cutting them with a farinatome or by hand in the middle with a razor blade or scalpel (ICC method 129) [7],. Instrumental measurement of grain texture (hardness) of durum wheat lines was performed using the Texture analyzer TA.XT.plus (Stable Micro System, U.K.) Hardness is determined as the force required to break (crack) a grain of wheat, and is expressed in newtons (N). Measurements were made using a piercing attachment. The values of this indicator are expressed as the mean value of 15 measurements on one sample.

Data on the climatic conditions that prevailed during the vegetation period May-June on the experimental fields were obtained from the Republic Hydrometeorological Service of Serbia [8], (Table3).

Table 3: *Average values of climatic conditions measured at the location Zemun Polje*

Month	Year 2012	Year 2013
	Maximum temperature (°C)	
May	30.0	31.7
June	35.7	35.4
	Temperature upper 30 °C (25 °C) (days)	
May	1 (11)	3 (15)
June	19 (26)	9 (16)
	Minimum temperature (°C)	
May	6.9	6.2
June	8.1	9.3
	Average mean temperature (°C)	
May	17.3	18.2
June	24.0	20.7
	Average relative humidity (%)	
May	71	66
June	56	71
	Precipitation sum (mm)	
May	75.4	98.6
June	15.8	39.2

2. Results and discussion

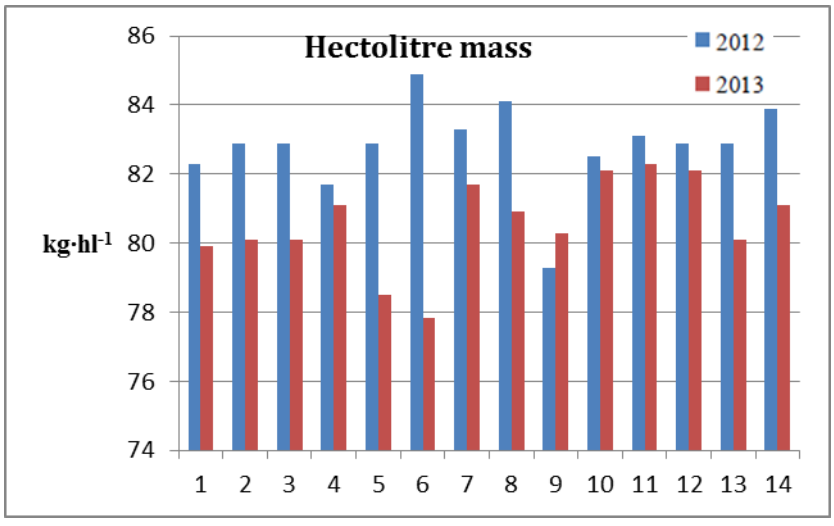
In the wheat growing season in May and June, which affects the quality and quantity of protein and starch in the wheat grain, the two production years differed from each other in terms of the duration of high temperatures and the amount of precipitation. The year 2012 was characterized by longer heat stress in June, and the year 2013 by a higher total amount of precipitation, 50% higher in May and more than twice as high in June.

The obtained results of the analysis of the most important physical and chemical indicators of the quality of the tested samples of durum wheat genotypes showed that the average protein content, groats yield and hectoliter weight were significantly higher in 2012. (Table 4). However, it cannot be considered that a smaller quantity of proteins means a reduced quality because the values of SDS sedimentation and vitreousness of grains practically do not differ in both years.

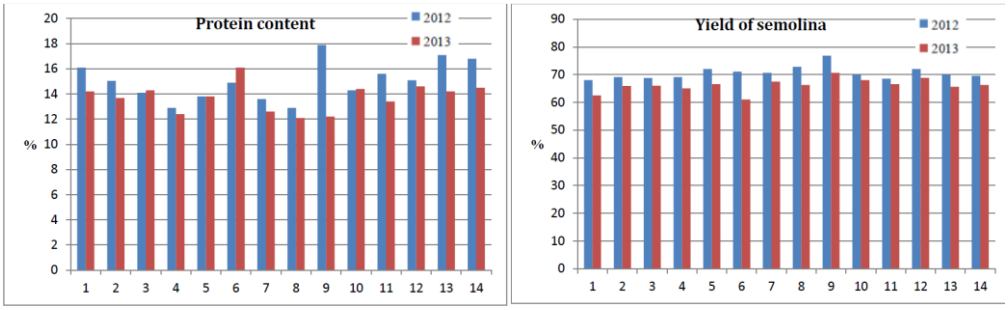
Table 4 : *Physical and chemical quality parameters of durum wheat genotypes in two production years (2012 and 2013)*

	Average		Minimum		Maximum	
	2012	2013	2012	2013	2012	2013
Hectoliter mass (kg/hl)	82,83	80,58	79,30	77,85	84,90	82,30
1000-grain weight (g)	45,17	43,06	39,28	35,83	54,15	51,76
Hardness (N)	13629,60	14590,07	10645,99	12788,64	16315,06	17298,97
Vitreousness (%)	92,57	92,43	80,00	83,00	98,00	98,00
Protein content(%)	15,01	13,75	12,90	12,10	17,90	16,10
Yield of semolina (%)	67,10	64,96	68,00	61,00	76,80	70,60
SDS sedimentation (ml)	21,79	20,57	15,00	15,00	30,00	28,00

The influence of chemical conditions on the most important technological quality parameters of individual samples of durum wheat genotypes are shown in comparison for the two production years 2012 and 2013, by histograms (Pictures 1, 2, 3 and 4).

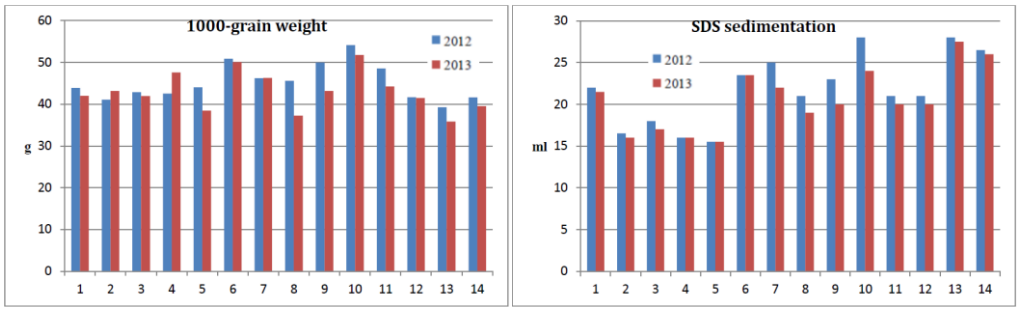


Picture 1. *The impact of climate change on hectoliter weights of samples of durum wheat genotypes for the two production years 2012 and 2013.*



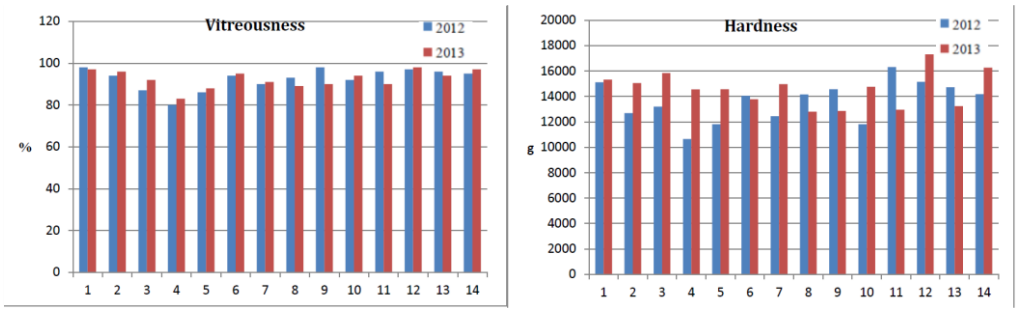
a) *b)*

Picture 2. *The impact of climate change on: a) protein content and b) yield of semolina of samples of durum wheat genotypes for the two production years 2012 and 2013.*



a) *b)*

Picture 3. *The impact of climate change on: a) 1000-grain weight and b) SDS sedimentation of samples of durum wheat genotypes for the two production years 2012 and 2013.*



a) *b)*

Picture 4. *The impact of climate change on: a) vitreousness and b) hardness of samples of durum wheat genotypes for the two production years 2012 and 2013.*

Within the research, a significant positive correlation was established for the following quality indicators (** significance threshold p<0.01): protein content and grain glassiness (0.749**), grain glassiness and grain hardness (0.696**), hectoliter mass and groats yield (0.531**), as well as protein content and SDS sedimentation (0.487**), which is in agreement with the results obtained by other authors [9], [10], [11].

The best qualitative indicators for the observed genotypes of durum wheat were recorded in 2012, which was extremely favorable for winter durum wheat in terms of temperature conditions, amount and distribution of precipitation in the period May-June during the period of vegetation. In contrast, higher amounts of precipitation during May and June 2013 led to lower values of quality parameters for all tested samples.

3. Conclusions

The obtained results indicate that all tested genotypes of durum wheat showed a very broad adaptability to different climatic conditions that prevailed in the two production years in the same locality and at the same time achieved good technological grain quality for the needs of the pasta industry.

On the experimental fields of the Zemun Polje Institute, new lines of durum wheat were created and grown, which best tolerate our climatic conditions and have good technological quality. By recognizing some of these lines as varieties, the production assortment of our climate would become richer by 2-3 new varieties characterized by high genetic potential of grains, excellent resistance to climatic conditions and stable technological quality.

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