



**ХАРАКТЕРИСТИКА НА МЕСТНИ И ИНТРОДУЦИРАНИ СОРТОВЕ ТВЪРДА  
ПШЕНИЦА (*TRITICUM DURUM* DESF.) В АГРОЕКОЛОГИЧНИТЕ УСЛОВИЯ  
НА СТРУМИЦА, РЕПУБЛИКА МАКЕДОНИЯ  
CHARACTERISTICS OF DOMESTIC AND INTRODUCED DURUM WHEAT  
VARIETIES (*TRITICUM DURUM* DESF.) IN THE AGRI-ENVIRONMENT  
CONDITIONS OF STRUMICA, REPUBLIC OF MACEDONIA**

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**Abstract**

The researches were conducted for two years (2009/2010 and 2010/2011), with eight winter durum wheat genotypes, including 2 domestic durum wheat varieties (*angela* and *mina*), one durum wheat variety introduced from Serbia (*pobeda-2*) and 5 durum wheat varieties introduced from Bulgaria (*predel*, *zvezdica*, *viktorija*, *progres* and *bulgaria*).

The highest average plant height, regardless of the years of research, had the *progres* variety (97.7 cm), and the lowest – the *angela* variety (72.7 cm). The highest average grain yield, regardless of the year of research, had the *progres* variety (6916 kg/ha), while the lowest (5100 kg/ha) – the *angela* variety. Regardless of the years of research and genotype, the general average grain yield of durum wheat amounted to 6,229 kg/ha. The highest absolute mass of grains, regardless of the year of examination, had the *progress* variety (55.7 g), and the lowest (45.8 g) – the *predel* variety. Comparison of the varieties shows statistically significant differences at the level of 0.05 and 0.01.

The hectoliter mass varies depending on the variety and year of cultivation. The biggest bulk mass of grains, regardless of the year of research, had the *progress* variety (80.03 kg/hl), and the lowest (75.19 kg/hl) – the *pobeda-2* variety. In the two years of research, there are high significant statistical differences among the varieties.

**Key words:** durum wheat, grain, height, yield, absolute mass, hectoliter mass.

## INTRODUCTION

Durum wheat (*Triticum durum* Desf.) takes approximately 8% of the production of wheat in the world (Decev et al., 2010). In R. Macedonia, durum wheat is grown on about 5% of the total area under wheat (Vasilevski, 2004). Regardless of the limited spaces, durum wheat is an economically important crop, because of the final product obtained from it. It features with hardwood grain, intersection is glassy, it has high protein content and healthy gluten, with high extensibility and elasticity, contributing durum wheat to be an important resource for the pasta industry.

According to Decev (2011) products from durum wheat are 30-40% more demanded on the market than those of soft wheat. Durum wheat are expected to gain increasing importance, since its products are more recommended for a healthy diet of modern man (FAO, 1998; Silano, 2008).

According to many authors, increasing the yield and quality of durum wheat depends on complex factors, including variety (Lalev et al., 1995), agri-environmental conditions, technology of cultivation and collection of wheat (Kolev et al., 2004), and the quality of the grain (Kolev et al., 2008), because of what, is necessary in a given area, to be grown the most productive varieties of durum wheat (Kolev et al., 2000).

The production is better if there are as many varieties as there are, because there is a greater choice, both in terms of productivity and in terms of quality properties for specific agro-ecological conditions. The use of multiple varieties in production in the same area provides successful opposition to limiting environmental factors, which achieves stable yield.

Given the above, the purpose of our investigation was to determine the production potential of many domestic and introduced durum wheat varieties in agro - ecological conditions of Strumica, to mention and recommend the most promising to the producers, breeders and industry in the country and roll as stable yielding and quality.

## MATERIALS AND METHODS

The research was conducted in field and laboratory conditions. The field trials were set up at the Faculty of Agriculture - Strumica, University "Goce Delchev" - Stip. The researches were conducted for two years (2009/2010 and 2010/2011), of eight winter durum wheat genotypes, including 2 domestic durum wheat varieties (*angela* and *mina*), one durum wheat variety introduced from Serbia (*pobeda-2*) and 5 varieties durum wheat introduced from Bulgaria (*predel*, *zvezdica*, *viktarija*, *progres* and *bulgaria*).

The experiment was consisted of 8 variants in three iterations, allocated by the method of random block system, with the dimension of the basic parcel of 5 m<sup>2</sup>. The distance between the variants was 0.50 m, and between repetitions – 1.0 m. The distance between the rows was 20 cm.

The seeding rate was 550 grains per 1 m<sup>2</sup>, i. e. 5.5 million grains of 1 ha. In all the years of research, the pre culture of wheat was potato.

In two years of research the soil was prepared in the same way. The main treatment was plowing at a depth of 35 cm, followed by fertilization by

methodological principle. So, on the surface provided for the experiment, artificial granulated NPK 15:15:15 fertilizer was inflicted, in an amount of 300 kg/ha. Sowing was performed manually, in rows at a depth of 5-6 cm. During the vegetation standard agrotechnics for field wheat production was used. Top fertilization was done with KAN 27%, in amount of 150 kg/ha, in the tillering stage of the wheat.

The height of a whole wheat plant is measured. 25 plants of each iteration is taken, so the average of 75 plants (3 x 25 plants) is taken. The grain yield is calculated in kg/ha, of the weight of grain obtained from each parcel, reduced to unit area. Before harvest, from each parcel, material of 1 m<sup>2</sup> of for laboratory analysis was taken, where from the physical properties the absolute and the hectoliter mass were analyzed, and from the biological properties the energy of germination and germination.

The quality of grain is examined by the methods of testing the quality of seed material of agricultural plants (Official Gazette of RM no. 61/2007 yr.), i. e., international methods of ISTA Rules. The results were statistically processed by the method analyses of variance and the differences were tested by LSD - test.

#### CLIMATIC CONDITIONS

During the two-year researches the meteorological indicators for the monthly average temperatures in degrees Celsius and monthly sums of precipitation in millimeters were monitored.

The mean annual temperature in Strumica valley (table 1), for a period of ten years 1998/2008, was 13.1°C. For a period of ten years 1998/2008 in Strumica valley, the average precipitations are 599.9 mm (table 2) .

Schedule of precipitation (table 2) by months and seasons is quite unbalanced. December has the most precipitations, with an average amount of 71.0 mm. Driest month, with the lowest average amount of rainfall is August, with e 32.8 mm.

**Table 1. Average monthly temperatures in degrees Celsius**

Year	Months												Annual amount of temp.	Aver. ann. temp.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
2009	1,8	3,4	7,6	13,2	18,9	21,8	24,9	23,7	19,3	13,4	8,5	6,0	4444,5	12,2
2010	3,7	5,4	8,6	13,9	18,5	22,1	24,5	26,5	19,7	11,6	11,6	3,7	5180,3	14,2
2011	2,5	3,9	8,4	12,9	16,8	22,3	25,8	25,4	22,1	11,4	3,9	2,4	4818,9	13,2
1998/2008	1,3	3,8	7,7	13,2	18,6	22,7	25,6	24,9	18,9	14,0	7,3	2,7	4795,5	13,1

**Table 2. Amount of monthly rainfall in mm**

Year	Months												Annual amount of rainfall in mm
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2009	87,8	20,1	91,0	31,6	67,1	72,3	17,5	101	13,0	96,0	29,8	113,8	741,0
2010	28,1	86,6	53,2	36,2	22,9	57,9	49,0	0,7	85,5	196,5	37,6	94,6	748,8
2011	25,2	20,6	43,2	14,8	53,6	25,8	14,7	26,5	49,9	29,8	7,5	45,9	357,5
1998/2008	39,9	37,8	38,2	42,6	57,9	56,8	37,1	32,8	58,5	70,5	56,8	71,0	599,9

According to the data in table 1, it can be concluded that the monthly average air temperatures during the vegetation of wheat, in both years of research

are lowest in the first months of each year, ie in January and February (from 1.8 to -5.4 °C), and highest in July and August (23.7-26.5°C).

Average monthly temperatures that are prevailing in the vegetation period are considered good for growing wheat. Winter wheat is known as a culture that does not set specific requirements to heat and is considered as resistant to low temperatures. According to Vasilevski (2004), the temperatures higher than 25°C and lower than 14°C, between the tillering and maturing stages, slowing the growth of plants. At temperatures above 28°C, warm wind and low relative humidity, comes to the so-called heat stroke. The most critical period for the occurrence of heat stroke is milky maturity stage when the yield can be reduced more than 50%.

Best results the wheat gives in areas with 650-800 mm annual rainfall. According Jevtich (1992), from eco-geographical aspect, wheat thrives in areas with very different amounts of rainfall and schedule. In table 2 we can see that the annual amounts of rainfall in the Strumica region during the research period is within the optimal needs of wheat. According to Vasilevski (2004), a critical period for water for the wheat is 15 days before and 6 days after the ear appearance. From the data in table 2, it can be noted that in 2011, during the vegetation period of wheat, the biggest deficit of rainfall has seen in April (only 14.8 mm). In the other months and years, the distribution of rainfall is relatively good for meeting the water requirements for wheat, so there was no need for intervention irrigation.

## RESULTS AND DISCUSSION

### Plant height

The height of the stem is important feature of the durum wheat variety that depends on the genotype, on the environmental conditions in which the variety is grown and the applied agronomy practices. The most suitable varieties for achieving high and stable production are those with medium plant height. In our experiments, measuring the height of the plants was carried out in the full maturity stage of wheat. From the results (table 3), one can see that the plant height is moving in the range of 70.9 cm in 2009/2010 to 104.3 cm in 2010/2011.

**Table 3. Plant height in cm in the studied variants in durum wheat production**

Genotype	Year		Average by genotype
	2009/2010	2010/2011	
<i>predel</i>	97,3	87,8	92,5
<i>zvezdica</i>	88,1	98,8	93,4
<i>viktorija</i>	87,5	100,3	93,9
<i>progres</i>	91,1	<b>104,3</b>	<b>97,7</b>
<i>bulgaria</i>	81,2	90,1	85,6
<i>angela</i>	<b>70,9</b>	74,6	<b>72,7</b>
<i>pobeda-2</i>	78,5	93,3	85,9
<i>mina</i>	80,0	97,2	88,6
<b>Average by year</b>	<b>84,3</b>	<b>93,3</b>	<b>General average 88,8</b>
<b>LSD (0,05)</b>	<b>0,64</b>	<b>1,24</b>	
<b>(0,01)</b>	<b>0,99</b>	<b>1,90</b>	

Regardless the years of research and genotype, the general average height of the plants was 88.8 cm.

In the first year of the research (2009/2010), the average height of the plants in durum wheat, irrespective of the varieties was 84.3 cm. Maximum height of the plants in this year's research has the variety *predel* (97.3 cm), and the lowest (70.9 cm) variety *angela*. Compared between varieties, there are statistically significant differences.

In the second year of the survey (2010/2011), the average height of the plants in durum wheat, irrespective of the varieties was 93.3 cm. Maximum height of the plants in this year's research has the variety *progres* (104.3 cm), and the lowest (74.6 cm) variety *angela*.

The highest average plant height in wheat, in two years of research, regardless the years of research, had variety *progres* (97.7 cm), and the lowest in two years of research had a variety *angela* (72.7 cm).

According to Kolev (2010), who was examining four French varieties and one Bulgarian durum wheat variety, in terms of South Bulgaria, the plant height ranges from 85.3 cm in French variety *exodur*, up to 94.2 cm in Bulgarian variety *progres*. Our results are in agreement with the results from the author.

#### Grain yield

Yield which is obtained from cultivated plants has always been the center of attention in humans. Therefore, in most scientific papers, yield is a parameter from which meaningful conclusions can be received and made.

The yield is quite variable feature. The most it depends on soil and climatic conditions, agricultural practices applied and the genotype.

From the results (table 4), one can see that it ranges between 4500 to 7066 kg/ha. Regardless of years of examination and the genotype, overall average grain yield of durum wheat amounted to 6229 kg/ha.

**Table 4. Grain yield in kg/ha in durum wheat production**

Genotype	Year		Average by genotype
	2009/10	2010/11	
<i>predel</i>	5900	6266	6083
<i>zvezdica</i>	7000	6600	6800
<i>viktorija</i>	6800	5766	6283
<i>progres</i>	6800	7033	<b>6916</b>
<i>bulgaria</i>	7000	5566	6283
<i>angela</i>	5700	<b>4500</b>	<b>5100</b>
<i>pobeda-2</i>	5866	5466	5666
<i>mina</i>	6333	<b>7066</b>	6699
<b>Average by year</b>	<b>6425</b>	<b>6033</b>	<b>General average 6229</b>
<b>LSD (0,05) (0,01)</b>	<b>0,48 0,21 H C 0,33</b>		

The highest average grain yield, regardless the year of examination, had variety *progres* (6916 kg/ha), while the lowest (5100 kg/ha), variety *angela*.

Regardless the year of examination and climate conditions, high average grain yield gave varieties *zvezdica* (6800 kg/ha), *mina* (6699 kg/ha) and *viktorija*

and *bulgaria* (6283 kg/ha). Compared between varieties, there are proven statistically significant differences. These varieties can serve as future basic genetic material in the plant breeding for creating varieties in which we want to emphasize this feature. Thus it can be concluded that the differences that occur between varieties in the same conditions of cultivation is due to the variety specificity, i. e. the specific genetic characteristics that possess the genotypes tested. Decev (2010) for a period of eleven years has conducted trials of four durum wheat cultivars with different levels of fertilization. He concluded a large variability in yield among varieties and year of research. Average yields ranged from 4158.4 kg/ha in variety *zagorka*, to 4337.3 kg/ha in variety *vazhod*. It is in accordance with the researches of other authors (Tancev, 2010); (Kolev, 2008); (Kolev, 2012).

#### **Physical properties of the seed** **Absolute and hectoliter mass**

According to Djokić (1998), the absolute and the hectoliter mass have great impact on the yield and its stability. Absolute mass is the mass of 1000 air dry grains expressed in grams. It is characteristic of the species and variety, and the same variety it can be different, depending on the conditions of production. By default, the seed of the same variety and the same reproduction, which has a greater absolute mass, allows more vital plant growth in the initial stages of development.

The results for the absolute mass of the grain in durum wheat production are shown in table 5, and it can be seen that it is moving in the range of 41.8 to 56.9 g. Regardless the years of examination and genotype, the absolute mass of durum wheat in our tests is 48.1 g.

**Table 5. Absolute mass (g) and hectoliter mass (kg/hl) in durum wheat production**

Genotype	Absolute mass by years		Average by year	Hectoliter mass by year		Average by genotype
	2009/10	2010/11		2009/10	2010/11	
<i>predel</i>	45,5	46,2	<b>45,8</b>	75,20	80,20	77,70
<i>zvezdica</i>	50,6	42,8	46,7	78,18	79,39	78,78
<i>viktorija</i>	46,4	46,3	46,3	76,14	79,68	77,91
<i>progres</i>	54,6	<b>56,9</b>	<b>55,7</b>	77,23	<b>82,83</b>	<b>80,03</b>
<i>bugarija</i>	52,9	47,8	50,3	77,30	81,36	79,33
<i>angela</i>	50,5	<b>41,8</b>	46,1	76,06	78,53	77,29
<i>pobeda-2</i>	47,8	46,0	46,9	<b>72,25</b>	78,13	<b>75,19</b>
<i>mina</i>	46,6	47,7	47,2	76,58	80,18	78,38
<b>Average by year</b>	<b>49,4</b>	<b>46,9</b>	<b>General average 48,1</b>	<b>76,11</b>	<b>80,03</b>	<b>General average 78,07</b>
<b>LSD (0,05)</b>	<b>2,32</b>	<b>4,80</b>		<b>1,05</b>	<b>0,29</b>	
<b>(0,01)</b>	<b>3,56</b>	<b>7,40</b>		<b>1,61</b>	<b>0,45</b>	

In the first year of the research (2009/2010), the absolute mass of durum wheat, irrespective of the varieties was 49.4 g. The greatest absolute mass of grain

in this year's examination had variety *progres* (54.6 g), and the lowest (45.5 g) the variety *predel*. There are statistically significant differences between varieties.

In the second year (2010/2011) of research, the absolute mass of durum wheat, irrespective of varieties, was 46.9 g. The greatest absolute mass in this year of research, also had variety *progres* (56.9 g), and the lowest (41.8 g) variety *angela*. There are many statistically significant differences between varieties.

The greatest absolute mass of the grains, regardless of the year of research, had variety *progres* (55.7 g), and the lowest (45.8 g), variety *predel*.

In the variety tests of Kolev (2010), the absolute mass ranges from 37,5 g in French variety *exodur* to 50.3 g at Bulgarian variety *progres*. Our results are in agreement with the results from the author. It complies with the tests of (Kolev, 2008, 2012).

The hectoliter mass mean mass of some seeds in a volume of 100 liters or a mass expressed in kilograms per hectoliter. The hectoliter mass is a summary indicator for the grain filling. The hectoliter mass, as a physical property, is a rough index of yields of the flour (Zélèny, 1978, cited by Menkovska, 2003).

The results for the hectoliter mass are shown in table 5. From the results we can see that it varies in the range from 72.25 to 82.83 kg/hl. Regardless the years of research and genotype, the hectoliter mass of grain was 78.07 kg/hl.

The hectoliter mass varies depending on the variety and year of cultivation. The biggest bulk mass of grains, regardless of the year of research, had variety *progres* (80.03 kg/hl), and the lowest (75.19 kg/hl), variety *pobeda-2*. There are high significant statistical differences between varieties in both years of research.

In the variety tests of Kolev (2010, 2012), the greatest mass of bulk grains, regardless of the year of research, had variety *progres*. Our results are in agreement with the results from the author.

### **Biological properties of the seed Germination viability and germination**

The germination of the seed is one of the most important quality properties of seeds. By examining the germination one can determine the percent of basic culture seed can give normal germs under laboratory conditions, which in favorable conditions in the soil can be developed into normal plants. The germination is determined on clear seed of the working sample.

The germination viability is the number of normal germs in terms of the number of seeds placed on germination, established after the expiry of the time provided for the first assessment.

The total germination of the seed is number of normal germs in relation to the total number of seeds placed on germination, determined after the expiration of the time provided for final grading.

From the results for the germination viability and germination, shown in table 6, can be seen that it is in the range of 88.3% to 99.3%.

**Table 6. Germination viability (%) and total germination (%) in durum wheat production**

Genotype	Germination viability by years		Average by genotype	Total germination by years		Average by genotype
	2009/2010	2010/2011		2009/2010	2010/2011	
<i>predel</i>	94,6	93,6	94,1	96,0	99,0	97,5
<i>zvezdica</i>	93,0	97,6	95,3	94,3	99,6	96,9
<i>viktorija</i>	95,6	95,3	95,4	96,3	98,3	97,3
<i>progres</i>	91,0	93,0	92,0	93,6	99,3	96,4
<i>bugarija</i>	89,7	93,3	<b>91,5</b>	<b>92,6</b>	99,0	<b>95,8</b>
<i>angela</i>	94,7	<b>88,3</b>	<b>91,5</b>	96,3	97,0	96,6
<i>pobeda-2</i>	94,0	<b>99,3</b>	<b>96,6</b>	95,3	<b>100,0</b>	97,6
<i>mina</i>	95,3	90,6	92,9	98,0	98,6	<b>98,3</b>
<b>Average by year</b>	<b>93,5</b>	<b>93,8</b>	<b>General average 93,7</b>	<b>95,3</b>	<b>98,8</b>	<b>General average 97,0</b>
<b>LSD (0,05) (0,01)</b>	<b>5,0 HC</b>	<b>5,2 8,1</b>		<b>HC HC</b>	<b>1,45 2,23</b>	

Regardless the years of research and genotype, germination viability of durum wheat in our tests is 93.7%.

In the first year of the survey (2009/2010), the germination viability of durum wheat, irrespective of the varieties was 93.5%. The greatest germination viability in this year's examination had variety *viktorija* (95.6%) and the lowest (89.7%) variety *bulgaria*. Between varieties there are significant statistical differences at a level of 0.05.

In the second year (2010/2011) of the research, the germination viability of durum wheat, irrespective of varieties accounted for 93.8%. The greatest germination viability in the test this year was variety *pobeda-2* (99.3%) and the lowest (88.3%) variety *angela*. Between varieties there are many significant statistical differences.

The greatest germination viability, regardless the year of research, had variety *pobeda-2* (96.6%) and the lowest (91.5%), and varieties *angela* and *bulgaria*.

According Delchev (2008), who was doing researches on the impact of five stimulators used during the vegetation of durum wheat on germination viability and total germination the used stimulators influenced the increase in germination viability and total germination.

The results for total germination in durum wheat production are shown in Table 6.

From the results we can see that the overall germination varies in the range of 92.6% to 100%. Regardless the years of research and genotype, total germination of the seed was 97.0%.

The highest total germination, regardless of the year of research, had variety *mina* (98.3%) and the lowest (95.8%), variety *bulgaria*. In the second year of research between varieties there are high significant statistical differences.

## CONCLUSION

Based on two years of research on the characteristics of domestic and introduced durum wheat varieties, the following conclusions can be made:

1. The greatest average height of wheat plants in the two years of research, regardless the years of research, had variety *progres* (97.7 cm), and the lowest, the variety *angela* (72.7 cm).

2. The highest average yield, regardless the years of research, had variety *progres* (6916 kg/ha), while the lowest (5100 kg/ha) *angela*. Regardless the genotype variety and the years of examination, the general average grain yield of durum wheat is 6229 kg/ha.

3. The greatest absolute mass of the grains, regardless of the year of research, had variety *progres* (55.7 g), and the lowest (45.8 g), variety *predel*. Compared between varieties, there are statistically significant differences at the level of 0.05 and 0.01.

4. The hectoliter mass varies depending on the variety and year of cultivation. The biggest bulk mass of grains, regardless of the year of research, had variety *progres* (80.03 kg/hl), and the lowest (75.19 kg/hl), variety *pobeda-2*. There are high significant statistical differences between varieties in both years of research.

5. The greatest germination viability, regardless the year of research, had variety *pobeda-2* (96.6%) and the lowest (91.5%), and varieties *angela* and *bulgaria*.

6. The highest total germination, regardless of the year of research, had variety *mina* (98.3%) and the lowest (95.8%), variety *bulgaria*. In the second year of research between varieties there are high significant statistical differences.

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