PRODUCTION POTENTIAL OF WHEAT IN STRUMICA REGION

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ABSTRACT

Tests were performed during 2006/07 and 2007/08 on 14 varieties of soft winter wheat, of which 9 are registered varieties (*milenka, bistra, bargala, radika, NS rana 5, pobeda, mila, skopjanka, bezostaja*) and five perspective lines (*line 67/7, line 67/7-2, line 65/5-1, line 67/8-2 and line 55/5*).

The greatest height reached *bezostaja* variety (103,8 cm), and the smallest variety *mila* (87,9 cm). Regardless of year of examination and varieties, the general average height of the plants in winter wheat was 95.5 cm. The average yield ranged from 2.830 kg/ha in variety *bezostaja* to 8.620 kg/ha in variety *bistra*. Regardless of the year of examination and genotype, the general average grain yield of wheat was 6847 kg/ha. The average 1000-kernel weight ranged from 42,3 g in variety *bargala* to 54,8 g the variety *bistra*. Regardless of the year of examination and genotype, the 1000-kernel weight of wheat in our tests was 50,2 g. Compared between varieties, there are statistically significant differences at the level of 0.05 and 0.01. The biggest hectolitre mass of grains, regardless of the year of examination, had *line 67/7-2* (78,88 kg / hl), and the lowest, variety *bargala* (74, 66). Regardless of the year of examination and genotype, the hectolitre mass of grain was 76,81 kg/hl. Compared between varieties, there are statistically significant differences at the level of 0.05 and 0.01.

***Key words**: wheat, grain, height, yield, 1000-kernel weight, hectolitre mass*

INTRODUCTION

Soft wheat (*Triticum aestivum* spp. *vulgare*) is the basic grain crop and the most important bread crop in Republic of Macedonia. In our country, the area of production and the average yield of wheat, in the period after World War II until today, have changed, depending on the needs, state policy, soil and climatic conditions that prevailed during the years of production. According to Egumenovski et al. (2003), in the Republic of Macedonia, in the period 1990-1995, the wheat is planted on area of 112,811 ha. The average yield for the period 2000 – 2007 is 2670 kg/ha (State Institute of Statistics of Republic of Macedonia).

Relatively low and unstable average yields of this cereal crop and a growing need and demand for it, worldwide, greatly influence to continue further studies in this crop, from different aspects, and with one purpose, which is stabilizing and increasing the yield. Therefore, each developed country with long-term investment plans, in their priorities has outlined ways to preserve and stabilize the domestic production of this crop with number of measures, laws and regulations.

For the intensification of production of wheat, despite environmental conditions and the level of technology, the use of varieties with high genetic potential of reproduction is extremely important.

Variety as a factor is of great importance to intensifying production, given that its share in achieving the average yield is about 50%, according to Jevtić (1989) and Borojević & Mishić (1987).

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

The modern trends in plant breeding today, create varieties that are genetically different interconnected so that they can successfully resist adverse environmental factors and can complement each other in yield and quality.

Given the above, the purpose of our investigation was to determine the production potential of many varieties and lines of wheat in agro-ecological conditions of Strumica region, to mention and recommend the most promising producers, breeders and industry in the country and outside our state and promote them as stable yielding and quality.

MATERIAL AND METHODS

Tests were conducted in field and laboratory conditions. The field trials were set on the experimental field of Agricultural Faculty – Strumica at the University Goce Delchev – Stip. Tests were performed during 2006/07 and 2007/08 on 14 varieties of soft winter wheat, of which 9 are registered varieties (*milenka, bistra, bargala, radika, NS rana 5, pobeda, mila, skopjanka, bezostaja*) and five perspective lines (*line 67/7, line 67/7-2, line 65/5-1, line 67/8-2 and line 55/5*).

Varieties *milenka, bistra* abd *radika* are selections of the Agricultural Institute - Skopje, varieties *mila* and *bargala* are selections of Agricultural Faculty – UGD Stip, varieties *NS rana 5* and *pobeda* are selections of the Institute for crop and vegetable production in Novi Sad, *bezostaja* is a Russian breed, the lines are selections of Agricultural Faculty – UGD Stip.

The experiment was consisting of 14 variants in four iterations, divided by the method of random block system, with the dimension of basic parcel of 5 m^2. The distance between the variants was 0,50 m, and between repetitions 1,0 m. The distance between rows was 20 cm. The seeding rate was 300 kg/ha or 30 g/m^2, respectively 6 000 000-6 500 000 grains per ha. In all years of testing pre crop of wheat was potato.

In two years of testing the soil was prepared in the same way. The main treatment was plowing the surface at a depth of 35 cm, followed by fertilization by methodological principle (artificial granulated NPK 15:15:15 fertilizer 300 kg/ha was applied). Sowing was performed manually in rows at a depth of 5-6 cm. During the vegetation is used for standard agrotechnics for field wheat production.

Top fertilization of the crop was done with KAN 27% , 150 kg/ha, in the tillering stage of the wheat.

The height of the whole plant of wheat, on 25 plants, from each iteration, was measured, whereby the average of 100 plants (25 plants x 4) was taken. The grain yield rain is calculated in kg/ha on the weight of grain produced from each parcel, reduced to unit area.

Before harvest, material from 1m^2 of each parcel is taken for laboratory analysis. In the laboratory the 1000-kernel weight and the hectoliter mass were analyzed.

The results are processed statistically by the method for analysis of variance, and differences are tested by LSD-test.

CLIMATIC CONDITIONS

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

The annual average temperature in Strumica valley (table 1) for a period of ten years 1995/2005, was 12,8 °C. For a period of ten years 1995/2005 in Strumica valley the average precipitations was 660,1 mm (table 2).

The schedule of precipitation (table 2) by months and seasons is quite unbalanced. The most rainy is December with an average amount of 81,9 mm. The most arid is June, with the lowest average rainfall of 31,9 mm.

The analysis of the temperature in the period 2006-2008 (Table 1) showed high similarity with the annually average temperature in the ten-year average. The average annual temperature in

2006 is the same with annual average temperature. In 2007 was about 1,3 °C higher in 2007 is 1,2 °C higher than average.

According to the data in Table 1 it can be concluded that the monthly average air temperatures during the vegetation of wheat in the four years of testing are lowest in the first months of each year, ie in January and February (from 1,1 to 3,4 ° C) and highest in July (23,7 - 27,6 °C). Monthly average temperatures prevailing in the vegetation period is considered as good for growing wheat. Winter wheat is known as a culture which does not set specific requirements to heat and are considered resistant to low temperatures.

Table 1. Mounthly average temperatures in Celsius degrees

Year	Mounths												Annual sum of temp.	Aver. ann. temp.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
2006	-0,3	2,0	8,2	13,5	18,1	21,4	23,7	24,1	19,5	14,3	6,7	2,8	4672,0	12,8
2007	5,0	5,9	9,8	13,7	19,8	24,1	27,6	24,6	17,7	13,3	5,9	1,9	5146,5	14,1
2008	2,8	5,9	9,9	13,5	18,0	23,2	25,3	26,8	18,7	11,6	8,0	5,1	5135,6	14,0
1995/ 2005	1,1	3,4	7,6	12,3	18,0	22,4	24,5	24,0	18,3	12,6	5,3	3,8	4679,9	12,8

Table 2. Sum of mounthly precipitations in mm

Year	Mounths												Annula sum of precipitation
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2006	58,7	56,4	75,0	31,8	34,0	107	26,7	19,9	63,9	85,6	39,7	34,3	632,9
2007	16,5	24,0	39,7	2,2	107,5	45,6	0,3	73,9	41,0	127	74.8	41.4	593,7
2008	16,1	17,1	16,8	61,2	49,8	35,5	8,7	2,5	76,9	57,8	20,7	95,4	458,5
1995/ 2005	51,9	45,5	42,8	35,6	57,2	31,9	90,5	54,0	63,3	39,4	58,9	89,1	660,1

According to Vasilevski G. (2004), higher temperatures of 25 °C and lower than 14 °C between the tillering and maturing stage, are slowing the growth of plants. At temperatures above 28 °C, warm wind and low relative humidity, comes to so-called heat stroke. The most critical period for the occurrence of heat stroke is milky maturity stage when the yield can be reduced for more than 50%.

Wheat gives the best results in areas with 650-800 mm annual precipitations. According to Jevtić S. (1992), from eco-geographical aspect, wheat thrives in areas with very different amounts and schedule of precipitations.

In Table 2 we can see that the annual amounts of rainfall in the Strumica region during the test period is within the optimum for the wheat.

According to Vasilevski G. (2004), a critical period for water for wheat is 15 days before and 6 days after heading stage.

From the data in Table 2, it can be seen that in 2007 during the vegetation period of wheat in April, had the highest deficit of precipitations (only 2,2 mm). The other months and years, the distribution of precipitation is relatively good for the needs of water for wheat, so there was no need for intervention irrigation.

RESULTS AND DISCUSSION

Plants height

The height of the plant is important variety feature which depends of the genotype, the environmental conditions in which the variety is grown and applied agrotechnics.

The most suitable varieties to achieve high and stable production are those with medium plant height. In our tests, measuring the height of the plant was conducted in the fully maturity stage of the wheat.

The results for the plants height in the production of soft wheat are shown in Table 3.

Table 3. Plants height in cm at the tested variants in production of soft wheat

Genotype	Year of production		**Average by genotype**
	2006/07	**2007/08**	
67/7	90,5	93,3	91,9
67/7-2	98,0	98,5	98,2
65/5-1	97,7	98,2	97,9
67/8-2	92,5	93,5	93,0
Milenka	92,7	93,3	93,0
Bistra	95,5	94,3	94,9
Bargala	92,7	92,9	92,8
Radika	93,6	93,2	93,4
NS rana 5	94,8	95,0	94,9
Pobeda	96,6	97,2	96,9
55/5	100,3	100,0	100,1
Mila	**87,9**	88,0	**87,9**
Skopjanka	97,9	98,2	98,0
Bezostaja	103,3	**104,4**	**103,8**
Average by year	**95,3**	**95,7**	**General average 95,5**
LSD (0,05) 8,97 (0,01) N S			

From the results in Table 3, it can be seen that the plants height is moving in the range of 87.9 cm in 2006/2007 to 104,4 cm in 2007/2008. Regardless the year of production and genotype, the general average height of the plants was 95,5 cm.

In examination of 285 genotypes of spring wheat in the period 1995-1997, Rončević et al. (1998), established the average height of the plants, so that the varieties of Yugoslav origin the height was 63,1 cm, at the Russian-Ukrainian varieties 89,3 cm, with varieties from East Faroe Islands 60,5 cm, 62,1 cm Mexican varieties and 64,6 cm for all regions.

In the first year of the survey (2006/07), the average height of the wheat plant, regardless of variants, was 95,3 cm. The greatest height of the plants in this year's examination had variety *bezostaja* (103,3 cm), and the lowest (87,9 cm) variety *mila*.

Compared between varieties, there are statistically significant differences.

In the second year of the survey (2007/08), the average height of the wheat plant, regardless of variants, was 95,7 cm. The greatest height of the plants in this year's examination had variety *bezostaja* (104,4 cm), and the lowest (88,0 cm) variety *mila*.

The greatest average height of wheat plants in the two years of testing, regardless of year of production, had a variety *bezostaja* (103,8 cm), and the lowest in two years of examinations, the variety *mila* (87,9 cm).

Cenovet al. (1995) made a comparative examination of 15 soft winter wheat lines with three standard varieties grown in Bulgaria, whereby in 1993 the average height of the examined lines ranged from 85 cm in 5554-2 to 110 in 6399-4 cm and 668 2, whereas in 1994 it ranged from 80 cm in 5554-2 to 105 cm in 6399-4 and 668-2. Our results are consistent with results from the author.

Regardless of the year of examinations and genotype, overall average height of the plants in winter soft wheat was 95,5 cm.

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 are brought and made.

The yield is quite variable feature. The most it depends on soil and climate conditions, agro-technical measures applied and genotype.

The results for grain yield in production of wheat are shown in Table 4.

Table 4. Grain yield in kg/ha in production of soft wheat

Genotype	Year of production		**Average by genotype**
	2006/07	**2007/08**	
67/7	7 500	7 200	7 350
67/7-2	7 760	7 560	7 660
65/5-1	5 600	7 120	6 360
67/8-2	5 420	6 320	5 870
Milenka	7 820	7 740	7 780
Bistra	**8 720**	8 520	**8 620**
Bargala	6 000	6 720	6 360
Radika	8 660	8 360	8 510
NS rana 5	7 920	8 000	7 960
Pobeda	7 160	7 400	7 280
55/5	5 720	5 560	5 640
Mila	6 700	6 820	6 760
Skopjanka	6 760	7 000	6 880
Bezostaja	**2 500**	3 160	**2 830**
Average by year	**6 731**	**6 963**	**General average 6 847**
LSD (0,05) **(0,01)**	433,3610 626,7 N S		

From the results in Table 4, one can see that grain yield ranges from 2500 to 8720 kg/ha. Regardless of the year of production and genotype, the general average grain yield of wheat was 6847 kg/ha.

Highest average yield, regardless of the year of production, had variety *bistra* (8620 kg / ha), while the lowest (2830 kg/ha) *bezostaja* variety.

Regardless of year of production and weather conditions, high average grain yield gave varieties *radika* (8510 kg/ha), *N S rana 5* (7960 kg/ha) and *milenka* (7780 kg/ha). High grain yield gave new lines 67/7 and 76/7-2.

These varieties can serve as a future basic genetic material in plant breeding for creating varieties in which we want to emphasize this feature.

It can be concluded that the differences that occur between varieties equal in terms of cultivation are due to the variety specificity, ie the specificity of genetic features that have examined genotypes.

Marinković, Lj. (2004/05) in the two-year investigation of six selections in the Center for cereals in Kragujevac (*Kg-56, Kg-100, takovcanka, vizija, matica* and *lazarica*) and two of the Agricultural Institute of Skopje (*milenka* and *bistra*) at the Skopje region, concluded a large variability in yield between varieties and year of production. Highest average yield in both years of testing varieties gave *Kg-56* (5670 kg/ha and 5033 kg/ha) and *matica* (5330 kg/ha and 4833 kg/ha).

Physical features of the seed

Absolute mass and hectolitre mass

According to Djokić et al. (1998), absolute mass and hectolitre mass have a major impact on yield and its stability.

Absolute mass is the weight of 1000 air dry grains in grams.

Absolute mass is characteristic of the species and variety, and in the same variety can be different, depending on the conditions of production. Generally, seed of the same variety and same reproduction, which has a greater absolute weight, allows plant growth to be more vital in the initial stages of development.

The results for the absolute mass of grain in wheat production are shown in Table 5.

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

Genotype	Absolute mass by year		**Average by genotype**	Hectolitre mass by year		**Average by genotype**
	2006/07	**2007/08**		**2006/2007**	**2006/2007**	
67/7	50,0	51,5	50,7	76,45	77,55	77,00
67/7-2	51,0	51,0	51,0	78,76	**79,00**	**78,88**
65/5-1	52,6	53,0	52,8	77,32	78,20	77,76
67/8-2	49,7	50,2	49,9	75,52	76,66	76,09
Milenka	51,9	51,3	51,6	75,92	76,00	75,96
Bistra	54,4	**55,2**	**54,8**	77,92	78,20	78,06
Bargala	**41,8**	42,8	**42,3**	**74,18**	75,15	**74,66**
Radika	52,0	53,0	52,5	75,78	76,35	76,06
NS rana 5	50,9	51,5	51,2	77,05	77,55	77,30
Pobeda	46,6	47,8	47,2	77,32	78,20	77,76
55/5	49,5	50,0	49,7	75,38	75,55	75,46
Mila	51,0	52,5	51,7	77,25	77,65	77,45
Skopjanka	51,0	51,5	51,2	76,72	77,20	76,96
Bezostaja	45,2	46,7	45,9	75,85	76,00	75,92
Average by year	**49,8**	**50,6**	**General average 50,2**	**76,53**	**77,09**	**General average 76,81**
LSD (0,05) **(0,01)**	1,57 2,73			0,89 1,56		

From the results for the absolute mass in production of wheat (Table 5) can be seen that it ranges from 41.8 to 55,2 g.

In the variety examinations of Simeonova et al. (2005/2006), the absolute mass ranges from 35,6 g to 45,5 g.

Regardless the years of examinations and genotype, the absolute mass of wheat in our tests was 50,2 g.

In the first year of the survey (2006/07), the absolute mass of wheat, regardless of varieties, was 49,8 g. The greatest absolute mass of grain in this year of examinations had line *65/5-1* (52,6 g), and the lowest (41,8 g) variety *bargala*. Between varieties there are very significant statistical differences.

In the second year (2007/08) of the test, the absolute mass of wheat, regardless of varieties, was 50,6 g. The greatest absolute mass of grain in this year of examinations had variety *bistra* (55,2 g), and the lowest (46,7 g) variety *bezostaja*. Between varieties there are very significant statistical differences.

Regardless of the year, the average 1000-kernel weight ranges from 42,3 g in variety *bargala* to 54,8 g in the variety *bistra*.

In the presented results of Simeonova et al. (2004) can be seen that the average, for the period 1997/98, the lowest 1000-kernel weight (39,1 g) had variety *partizanka*, and the greatest (42,7 g), variety *orovchanka*. The variety *bistra* had 42,0 g 1000-kernel weight. Our test results are consistent with the results of the above authors.

The hectoliter mass means mass of seeds in a volume of 100 liters or a mass expressed in kilograms per hectolitre. The hectoliter mass is a summary indicator for the fulfillment of the grain. The hectoliter mass as physical feature is a rough index for the yield of flour (Zélèny 1978 cited by Menkovska 2003).

Results for hektolitarskata table are shown in Table 5.

From the results we can see that it ranges from 74.18 to 79,00 kg/hl. Regardless of the year of examination and genotype, the hectoliter mass of grain was 76,81 kg/hl.

The hectoliter mass varies depending on the variety and year of cultivation. The biggest volume mass of grains, regardless of the year of examination, had line *67/7-2* (78,88 kg/hl), and the lowest (74.66 kg/hl), the variety *bargala*.

CONCLUSION

Based on two years of research on the production potential of soft wheat, the following conclusions can be made:

- Regardless of the year of production, the greatest height reached *bezostaja* variety (103,8 cm), and the smallest variety *mila* (87,9 cm). Regardless of years and varieties, the general average height of the plants in winter wheat was 95,5 cm.

- Regardless of the year of production, the highest average yield achieved variety *bistra* (8620 kg/ha), and the lowest average yield variety *bezostaja* (2 830 kg/ha). Regardless of the year of production and genotype, the general average grain yield of wheat was 6847 kg/ha.

- Regardless of the year of production, the average weight per 1000 kernels ranged from 42,3 g in variety *bargala* to 54,8 g the variety *bistra*. Regardless of year of production and genotype, the absolute mass of wheat in our tests was 50,2 g. Compared between varieties, there are statistically significant differences at the level of 0.05 and 0.01.

- Highest hectolitre mass of grains, regardless of the year of examination, had line *67/7-2* (78,88 kg/hl), and the lowest (74.66 kg/hl), variety *bargala*. Regardless of the year of examinations and genotype, hectoliter mass of grain was 76,81 kg/hl. Compared between varieties, there are statistically significant differences at the level of 0.05 and 0.01.

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