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## EFFECT OF GENOTYPES AND LOCATIONS ON WHEAT YIELD COMPONENTS

### SUMMARY

Due to the dominant role in world nutrition, wheat was given the character of a strategic product. Its participation in human nutrition is gradually decreasing in developed countries where changes in the nutrition structure have prioritized animal proteins. However, in underdeveloped countries where the phenomenon of hunger is present in a severe form, the main tendency is to provide a sufficient amount of it for the needs of the population's diet.

The paper examines the influence of genotype/variety and site on winter wheat yield components: length of ears, number of spikelets in the spike, number of grains in the spike and mass of grains per spike, during 2016/17. The tested factors exhibited a different impact and a strong intensity of influence on the parameters covered by the research. The cultivation site had a statistically significant influence on the length of the ear (spike), the number of spikelets in the spike and the number of grains in the spike. Within the wheat yield components, the factor of the genotype / variety had higher influence on the length of the spike. The genotype G2 had a longer spike (8.62 cm), the number of spikelets in the spike (18.30), the number of grains in the spike (42.58), and the grain weight per spike (1.57).

**Keywords:** wheat, variety, locality, yield components, correlations

### INTRODUCTION

Wheat (*Triticum sp. L.*) is one of the oldest and most important cultivated plants because today, wheat bread is used by more than 70% of the Earth's population. Likely, neither human population could develop without wheat nor wheat could survive without the presence of a man. Wheat had and will play the most important role in the nutrition of the population for a long time. Its participation in human nutrition is gradually decreasing in developed countries, where changes in the structure of nutrition made animal proteins prioritized.

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However, in underdeveloped countries where the phenomenon of hunger is present in a severe form, the main tendency is to provide a sufficient amount that will provide fulfillment of the needs in population's nutrition. The great influence of wheat in human nutrition influenced the development and improvement of the accompanying industry. It is known that the milling and bakery industry has developed very well and a number of other branches of the food industry that have wheat as their basis. Today, a large number of products derived from wheat are known. Further development of its processing technology will contribute to expanding the list of these products (Lakić *et al.*, 2018). According to FAO (2017), all types of wheat in the world are cultivated in 220.107.550 ha, and, in the Republic of Serbia about 588.820 ha. In addition to the main product, grain, a significant quantities of by-products stay in the field, in warehouses and in industrial production and processing.

The crisis to feed the ever-growing population is compounded by the counteracting issues of spatial allocation of land for accommodation vs. agriculture. This issue of food insecurity is further amplified by degrading soil fertility conditions, reduced crop productivity and unpredictable climate change, which are expected to worsen in the near future. Although several policies addressing food security have been initiated (Carraro *et al.*, 2015; FAO, 2015), one of the most challenging propositions is to achieve higher crop productivity under stressful environmental conditions. Agriculture as an occupation depends on the ability to cultivate crops suitable for a particular climate in a defined region. Prolonged exposure to high temperatures in rainfed areas of the world, may lead to drought stress (Abhinandan *et al.*, 2018). The characterization of a novel wheat expansin gene TaEXPB23 has also opened new avenues for the role of jasmonate-mediated abiotic stress tolerance. The expression of TaEXPB23 was induced under drought stress and following exogenous MeJA application (Han *et al.*, 2012).

The economic importance of wheat has its international regional basis. Due to the dominant role in world nutrition, wheat was given the character of a strategic product. Many countries do not produce wheat enough for fulfilling their needs and are forced to constantly import it. In such a situation there is dependence of these countries on major producers that dictate the conditions in the entire world wheat trade (Glamočlija *et al.*, 2015).

Wheat obviously took a very important place in international trade. Today, it is the basic food for over 70% of the country's population. Wheat bread with a nutritive, vitamin and energy value of 8,500-9,400 joules is more nutritious than the bread of other types of grain, as it contains 77-78% of carbohydrates, 16-17% of total proteins, 1.2-1.5% of oil, 0.5-0.8% of mineral salts (most salts of Ca, P, Fe) is rich in vitamins B (B1-thiamine, B2-riboflavin and PP (nicotinamide). Besides flour, significant by-products of wheat grains milling are wheat germs rich in easily digestible proteins and high-quality edible oil, and are used to prepare baby food and certain treats. The bran that is also obtained by the milling of wheat grains are important in the nutrition of domestic animals because they

have a high nutritional and energy value with proteins, carbohydrates, oil, mineral salts and 9% cellulose (Popovic, 2010; Ugrenović et al., 2015; 2018; Živanović et al., 2017a; 2017b; Stevanović et al., 2018). Germs has highest nutritional value with 30-40% of the total protein and 10-12% of the oil, and the smallest has a kernel wrapper, with a high percentage of cellulose and mineral salts. The aim of this work is to examine the impact of different agro-ecological conditions and cultivation sites on the productivity of winter wheat varieties of different lengths of the vegetation period.

## MATERIAL AND METHODS

Examination of the impact of different agro-ecological conditions and production potential of winter wheat cultivars of different lengths of the vegetation period was carried out during 2016/17. at two sites, namely: Leskovac (experimental plot PSSS Leskovac, village Pečenjevce) and Pančevo (experimental plot of PSS Institute Tamiš, Pančevo). On the land of type alluvium (Leskovac) (L1); and carbonate chernozem (Pančevo), were performed field demo - tests, (L2). In this study, the following two varieties of wheat were examined: Sothys, early variety with axis (G1) and Sosthenes, medium-late cultivar without axles (G2). The tested varieties originate from the French seed company Caussadesemences. Applied agro-technics at tests depended on the preconditions, agroecological conditions of the cultivation area and given mechanization. The pre-crop for wheat at the locality - Leskovac was maize, while in Pančevo, the pre-crop was soybean. After harvesting of pre-crop, fertilization was carried out with mineral nutrient NPK (15:15:15) in the amount of 300 kg ha<sup>-1</sup>, and then plowing in Leskovac, or disking with a heavy disks in Pančevo. Pre-sowing preparation included disking and seedbed tillering in Leskovac, and just harrowing in Pančevo. The sowing was done according to the sowing plan, in the density according to the manufacturer's recommendation (400 - 500 grains per m<sup>2</sup>), or the distributor of the variety. In Leskovac, sowing was done on November 21, 2016, and in Pančevo on October 29, 2016. Just after sowing rolling with a smooth roller was performed. Nutrient and foliar fertilization was carried out differently, depending on the site. In Leskovac, CAN (27% N) in the amount of 250 kg ha<sup>-1</sup> was applied during the stooling phase and, in the blade phase, phosphate fertilizer Asfer universal, in the dose of 3 kg ha<sup>-1</sup>, while in Pančevo for feeding was used AN (32% N) in the amount of 250 kg ha<sup>-1</sup> (in the stooling phase), and CAN in the amount of 130 kg ha<sup>-1</sup> at the beginning of the blade phase.

As part of the care measures, protection from weeds, from lodged (falling down), as well as the causative agent of pest diseases, were carried out, depending on the need. In Leskovac, only one treatment against weeds and disease causers was carried out with a combination of Metmark WG 0,01% and Excort 0,5 l ha<sup>-1</sup>. In Pančevo, two protective treatments were carried out. Quelex 0.6 l ha<sup>-1</sup> + Trend 0.2 l ha<sup>-1</sup> was used for the first treatment in Pančevo. In the second treatment, the combination Duett ultra 0.6 l ha<sup>-1</sup> and Fastac 10 EC 0.15 l

ha<sup>-1</sup> was used in Leskovac, while Ceres 0.6 l ha<sup>-1</sup> and Decis 0.2 l ha<sup>-1</sup> were used in Pančevo. Within the wheat yield components, the influence of variety and site on the length of the spike, the number of spikelets in the spike, the number of grains in the spike and the mass of grains per spike were studied.

Wheat harvest was done mechanically (by harvester) in full maturity, in the first decade of July (in Pančevo), or in the middle of the second decade of July (in Leskovac). Just before harvest, samples were taken and the necessary measurements of the basic components of the yield were made. The obtained results were processed statistically using the statistical package STATISTICA 12 and the results are shown in the table.

### Meteorological conditions

For the successful wheat cultivation and other herbaceous plants, meteorological conditions, especially thermal and humidity conditions, should be optimal or as close as possible to the optimum. Growth and development of cultivated plant species and their yield and quality depends largely of these. For the realization of the above program data on weather conditions obtained from meteorological stations in the experimental fields in Leskovac and Pančevo were used. Mean monthly air temperature and precipitation amounts per months of the wheat growing period in the year of examination, by location, are shown in Table 1.

Table 1. Average monthly air temperature (°C) and precipitation (mm), 2016/2017

Locality/ Mounts	X	XI	XII	I	II	III	IV	V	VI	Average
	Average month temperature of air (°C)									
Leskovac	11.9	6.8	-0.7	-5.8	9.2	10.3	11.3	16.7	21.9	9.1
Pančevo	10.0	6.1	-0.8	-4.9	3.3	9.5	11.4	17.4	22.7	8.3
	Summ of month precipitations (mm)									
Leskovac	82.0	131.0	12.0	44.0	49.0	39.0	69.0	82.0	19.0	527.0
Pančevo	85.4	83.2	6.6	22.6	20.2	32.6	45.8	57.3	27.0	380.7

The average air temperature for the wheat vegetation period in the year of testing ranged from 8.3°C in Pančevo to 9.1°C in Leskovac. On the other hand, a smaller amount of precipitation during the wheat growing period was registered at the locality of Pančevo (380.7 mm) and higher in Leskovac (527.0 mm).

## RESULTS AND DISCUSSION

In this study, the influence of variety / genotype, different lengths of vegetation period, and locality on wheat yield components were examined: length of spike, number of spikelets in the spike, number of grains per spike and grain mass per spike, Table 2-4.

The evaluation of the significance of the results obtained shows that there are statistically very significant differences between the genotype / variety and grain yield per class ( $F_{\text{exp}} = 6.384^{**}$ ), Table 3.

Table 2. Descriptive statistics for tested parameters

Parameter	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.	Std. Error
Length of spike	12	8.007	8.045	7.13	8.830	0.668	0.193
Number of spikelet at spike	12	17.342	17.550	15.200	19.200	1.073	0.309
Number of grains per spike	12	40.392	38.650	37.400	49.200	3.926	1.133
Mass of grains per spike	12	1.477	1.415	1.280	1.860	0.165	0.0476

Table 3. Anova for tested parameters

Effect	SS	Degr. of Freed.	MS	F (df 8)	p
Length of spike					
Intercept	<b>769.2805</b>	<b>1</b>	<b>769.2805</b>	<b>29176.25</b>	<b>0.000000</b>
Genotype	<b>4.5141</b>	<b>1</b>	<b>4.5141</b>	<b>171.21</b>	<b>0.000001</b>
Locality	<b>0.1587</b>	<b>1</b>	<b>0.1587</b>	<b>6.02</b>	<b>0.039728</b>
G x L	0.0243	1	0.0243	0.92	0.365163
Error	0.2109	8	0.0264		
Number of spikelet at spike					
Intercept	<b>3608.801</b>	<b>1</b>	<b>3608.801</b>	<b>11190.08</b>	<b>0.000000</b>
Genotype	<b>5.741</b>	<b>1</b>	<b>5.741</b>	<b>17.80</b>	<b>0.002919</b>
Locality	<b>3.741</b>	<b>1</b>	<b>3.741</b>	<b>11.60</b>	<b>0.009281</b>
G x L	0.608	1	0.608	1.88	0.207156
Error	2.580	8	0.322		
Number of grains per spike					
Intercept	<b>19577.84</b>	<b>1</b>	<b>19577.84</b>	<b>9457.894</b>	<b>0.000000</b>
Genotype	<b>57.64</b>	<b>1</b>	<b>57.64</b>	<b>27.846</b>	<b>0.000749</b>
Locality	<b>43.70</b>	<b>1</b>	<b>43.70</b>	<b>21.112</b>	<b>0.001768</b>
G x L	<b>51.67</b>	<b>1</b>	<b>51.67</b>	<b>24.960</b>	<b>0.001058</b>
Error	16.56	8	2.07		
Mass of grains per spike					
Intercept	<b>26.16653</b>	<b>1</b>	<b>26.16653</b>	<b>1718.656</b>	<b>0.000000</b>
Genotype	<b>0.09720</b>	<b>1</b>	<b>0.09720</b>	<b>6.384**</b>	<b>0.035437</b>
Locality	0.02613	1	0.02613	1.716	0.226512
G x L	0.05333	1	0.05333	3.503	0.098160
Error	0.12180	8	0.01523		

Statistically significant differences were found between the length of spike and the tested factors (genotype and locality),  $F_{\text{exp}} = 171.21^{**}$  and  $F_{\text{exp}} = 6.02^{**}$ , and significant between the number of spikelets in the spike and the tested factors (genotype and locality),  $F_{\text{exp}} = 17.80^{**}$  and  $F_{\text{exp}} = 11.60^*$ , Table 3.

Statistically very significant differences were found between the number of grains by spike and the tested factors (genotype, site and interaction G x L),  $F_{\text{exp}} = 27.846^{***}$ ,  $F_{\text{exp}} = 21.112^{***}$  and  $F_{\text{exp}} = 24.960^*$ , Table 3.

The results show that, on average, for examined factors, the length of the spike was 8.01cm (Tables 3 and 4). On average, for locality, smaller spikes (7.39 cm) had plants of genotype G1, compared to G2 (8.62 cm).

On average, for varieties, the locality in Leskovac measured a greater length of spike by 0.23 and 2.92% compared to the locality in Pancevo.

Table 4. Influence of genotype and locality on parameters of yield of wheat (cm)

Genotype	Locality		Average	IV	Std. Dev.	Std. Err.
	Leskovac	Pančevo				
Length of spike, LS						
G1	7.46	7.32	7.39	0.14	0.21	0.09
G2	8.78	8.46	8.62	0.32	0.19	0.07
Average	8.12	7.89	8.01	0.23	0.67	0.19
Number of spikelets per spike, NoSS						
G1	15.87	17.43	16.65	1.53	0.98	0.40
G2	17.70	18.37	18.30	0.67	0.65	0.26
Average	16.78	17.90	17.34	1.12	1.07	0.30
Number of grain per spike, NoGS						
G1	38.03	38.37	38.20	0.34	0.70	0.28
G2	46.57	38.60	42.58	7.97	4.67	1.91
Average	42.30	38.48	40.39	3.82	3.92	1.13
Mass of grain per spike, MGS						
G1	1.37	1.41	1.39	0.04	0.06	0.02
G2	1.68	1.45	1.57	1.23	0.19	0.08
Average	1.52	1.43	1.47	0.09	0.16	0.05

Parameter	LS			NoSS			NoGS			MGS		
	G	Y	GxY	G	Y	GxY	G	Y	GxY	G	Y	GxY
LSD												
0.5	0.22	0.22	0.31	0.76	0.75	1.07	1.92	1.91	2.71	0.17	0.16	0.23
0.1	0.32	0.31	0.44	1.10	0.09	1.56	2.79	2.78	3.94	0.24	0.23	0.34

The average number of spikelets in the spike, for the tested factors, was 17.34 (tables 3-4). The genotype G1 had a lower number of spikelets in the spike (16.65) compared to the genotype G2 (18.30). On the average for the genotypes examined, a greater number of spikelet were found for 1.12 in relation to the

locality in Leskovac at the site in Pančevo. The interaction of the genotype x year had a statistically significant effect on the number of spikelets in the spike.

Locality, genotype and interaction of genotype x locality had a statistically significant effect on the number of grains in the spike. The number of grains in the spike was on average for the tested factors, amounting to 40.39 (tables 3 and 6). On average for genotypes, a smaller number of grains in the spike (38.20) had the genotype G1 compared to the genotype G2 (42.58). The average values of the tested parameter for genotypes were higher at the locality in Leskovac by 3.82 compared to the locality in Pančevo.

The genotype and interaction of the genotype x locality had a statistically significant effect on the grain mass in the spike, while the locality had no statistically significant influence on the tested parameter. The weight of the grains per spike, on average, for the tested factors, was 1.59 g (Table 2-4). On average, for locality, the genotype G1 had a lower weight of grain per spike (1.39 g) compared to the genotype G1 (1.57 g). The average values for genotypes were higher at the locality in Leskovac (1.52 g) by 0.09 g compared to the locality in Pančevo (1.43 g).

The strong correlation was observed between the tested parameters, Table 5. The yield of grains per spike was in very strong correlation with the number of grains per spike ( $r = 0.73^{**}$ ), in a strong positive correlation with the spike length ( $r = 0.59^*$ ) and in positive relationship with the number of spikelets in the spike ( $r = 0.37$ ).

Table 5. Correlations between tested parameters

Parameters	Length of spike	Number of spikelets at spike	Number of grains per spike	Mass of grains per spike
Length of spike	1.00	0.63*	0.71**	0.59*
Number of spikelets at spike	0.63*	1.00	0.30 <sup>ns</sup>	0.37 <sup>ns</sup>
Number of grains per spike	0.71**	0.30 <sup>ns</sup>	1.00	0.73**
Mass of grains per spike	0.59*	0.37 <sup>ns</sup>	0.73**	1.00

The length of the spike was in a very strong positive correlation with the number of grains per spike ( $r = 0.71^{**}$ ) and in a strong positive relationship with the number of spikelets in the spike ( $r = 0.63^*$ ), Table 5.

The results of the research are in unison with the previous research (Popović, 2010; Ikanović et al., 2014; Janković et al., 2016; Terzić et al., 2016; 2017; Djekić et al., 2017; Đekić et al., 2017; 2018; Živanović et al., 2017a; 2017b; Ugrenović et al., 2015; 2018; Stevanović et al., 2018; Maksimović et al., 2018).

The use of biomass for bioenergy creates new business opportunities in agriculture sector. Bioenergy production can significantly contribute to the development of rural areas and encourage creating new supply chains for biomass feedstock.

The creation of new non-food markets for biomass could provide alternative income sources for farmers (EC 2012) Agricultural residues, may act as important source of renewable energy. However, despite progress in these segments of crop production, the greatest potential for the use of biomass as fuel is seen in field (Čurović *et al.* 2016; Ikanović *et al.*, 2019; Popović *et al.*, 2018; 2019).

### CONCLUSIONS

Based on our test results on the influence of the variety of different lengths of the vegetation period on the components of the winter wheat yield, which were carried out in different agro-ecological conditions, the following conclusions can be drawn:

- Meteorological conditions during the winter wheat vegetation period, especially the amount of precipitation, differed considerably in the cultivation sites, which also affected significant differences in the values of the tested parameters.

- By the analysis of variance statistically significant differences between genotypes / cultivars and cultivation sites in the parameters included in the survey were revealed. However, when it comes to certain features, this influence was of different character and intensity of action.

- Within the wheat yield components, the factor of the genotype / variety had higher influence on length of the spike. The genotype G2 had a longer spike (8.62 cm), the number of spikelets in the spike (18.30), the number of grains in the spike (42.58), and the grain weight per spike (1.57).

- The cultivation site had a statistically significant influence on the length of spike, the number of spikelets in the spike and the number of grains in the spike. The Leskovac locality recorded higher values for the spike length (8.12 cm), the number of grains in the spike (42.30) and the weight of the grains per spike (1.52), while at the locality of Pančevo there was a higher value for the parameter - number of spikelets in the spike (17.90).

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