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THE EFFECT OF SOWING TIME ON THE YIELD OF SOME WHEAT VARIETIES

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ABSTRACT

It frequently occurs that due to unfavorable climatic factors, sowing is not carried out at the optimum time so that the sowing must be done in the delayed sowing period. The aim of our research was to determine the yield and some qualitative components of several wheat varieties sown at the optimum time and in the delayed sowing time. The experiments were carried out in 2016/17 and 2017/18, in the area of Southern Serbia (Leskovac) with 5 wheat varieties (Opsesija, Avenue, Sosthene, Farinelli, and Darija), under the same agro-ecological conditions on alluvium soil. Sowing in 2016/17 was done on October 30th, and in 2017/18 on December 8th. According to the results of the experiments, it can be concluded that the grain moisture, 1000 grain weight, and hectolitre weight did not differ significantly between sowing terms, while there were significant differences among the varieties. The grain yield varied significantly, both depending on the sowing term and the wheat variety. The average decrease in yield in the delayed term compared to the optimal term was 24.8%. Thus, in the optimal term sowing varieties Avenue and Farinelli had the highest yields (7,760 and 7,170 kg ha^{-1}), while in the delayed time sowing varieties Darija and Avenue had the highest yields (5,370 and 5,290 kg ha^{-1}). The Darija variety had the least decrease in yield in the delayed sowing time, so we can recommend it for sowing in this area in the delayed term.

Keywords: *wheat, optimal term, delayed term, variety, yield.*

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INTRODUCTION

Wheat sowing at the optimum time is very significant, especially when it is considered from the aspect of vegetation length, timely wading and rooting of plants, plant development, nutrient utilization rate, and ultimately total wheat yield. It frequently occurs that due to unfavorable climatic factors, such as drought or heavy rainfall, a delay in the removal of the harvesting remains of the pre-crop and the like, sowing is not carried out at the optimum time. In the case of delayed sowing, the plants are underdeveloped, some of them decay during the winter, while in the spring, some stages of development are shortened, which altogether results in diminished yields (Tahir et al., 2009). Malešević et al. (2008) emphasize the significance of sowing time when the length of vegetation is in question, and in particular, its effect on the composition of plants, thus reducing the presence of weeds. The same authors emphasize that the wheat root sown in the optimum time develops better, goes deeper into the soil, making the plants better utilize water and minerals and have a higher above-ground mass, unlike plants sown outside the optimal time. Todorović et al. (2003) note that it is useful for plants to develop at least 3 leaves, to be well-pruned and in good condition before wintertime, thus creating the most favorable conditions for good plants hibernation. The fact that the decrease in yield resulting from delayed sowing cannot be substituted by other measures, even with the increased use of mineral fertilizers, has been reported according to the data of Protić et al. (2003). The importance of optimal sowing time, as one of the most important factors for the formation of cereal yields, has been reported by many authors (Baloch et al., 2010; Yajam and Madani, 2013; Aćin, 2017). Ali et al. (2010), in their research on the effect of sowing time on wheat yield, emphasize the fact that yield from delayed sowing (December 30th) may be 27.24% lower than the one sown in the optimal sowing time. Ali et al. (2004) point out that wheat sowing time, especially in countries with variable climates, plays a key role in yield formation, so that yield of delayed sowing can be reduced by 58.2%. Similar data are reported by Kumar et al. (2000), while Iqbal et al. (2001) draw attention to the fact that the reduction in wheat yield due to delayed sowing can range from 27 to 52%. Panković and Malešević (2006) stress a significant decrease in wheat yield when sowing is done after October. Similar data on wheat yield reduction due to the sowing outside the optimum time has been reported by Shah et al. (2006) and Qasim et al. (2008).

The aim of our research was to determine the yield, the weight of 1000 grains and the hectolitre weight of several varieties of wheat sown both at the optimum time and in the delayed sowing time.

MATERIAL AND METHODS

The experiments were performed in 2016/17 and 2017/18, in the area of Southern Serbia (Leskovac area) with 5 wheat varieties: Obsession and Darija (BC Institute Zagreb), Avenue and Sosthene (LG France) and Farinelli (KWS), in the same agro-ecological conditions on alluvium soil type. Sowing in 2016/17 was carried out on 30th October, while the sowing in 2017/18 was done on 8th December. Prior to the

setting up of the experiment, soil samples were taken from the plots for chemical analysis. The experiment was set by the block system with three repetitions. The pre-crop was corn. The cultivation of the soil involved the soil thinning that had to be done twice, during which 300 kg ha^{-1} NPK (16:16:16) of fertilizer was introduced. Fertilization with KAN fertilizer in the amount of 250 kg/ha was carried out in March, and weed and disease treatment were done in April with *Metmark WG* 0.01% and *Excorta* in the amount of 0.5 l / ha. Foliar fertilization was done with a mineral fertilizer in the form of a concentrated suspension (*Humisuper* at a dose of 3l / ha). The harvest was done at the stage of full maturity. The yield was calculated on each plot and reduced to 14% moisture in the grain. The results were statistically analyzed, based on the analysis of each sort, using WASP 1.0. software and are presented in tables and graphs.

CLIMATE AND SOIL CHARACTERISTICS

Table 1. Precipitation (mm) and mean air-temperature (^{0}C) in Leskovac.

Mounth	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Oct/Jun
The 2017/2018 growing season										
mm	117	73	140	48	55.5	131	43	91	88	786.5
^{0}C	12.6	7.0	4.0	3.2	3.7	7.1	14.2	19.1	20.9	10.2
The 2018/2019 growing season										
mm	5.0	57	19	58	55.5	8.0	38	99	68	407.5
^{0}C	12.9	7.3	4.4	-0.3	3.7	9.3	13.8	15.5	22.2	9.9

In 2017/2018, the total rainfall during the growing season was 786.5 mm, while the average temperature was 10.2^{0}C. Throughout this growing year, it should be emphasized that the higher total amount of precipitation was fairly well distributed, both during sowing and during the spring part of the vegetation. No negative average monthly temperatures during the winter months were noted which favored wheat production.

In the 2018/2019 growing year, which was unfavorable for wheat production, the total rainfall during the growing season was small and amounted to 407.5 mm, while the average temperature was 9.9^0C. It is significant to mention that the dry period during the autumn occurred in this growing season, and a total of 83 mm of rainfall fell in October, November, and December, which was insufficient to prepare the soil for sowing. So, this year, the sowing was done at the beginning of November. In addition, average temperatures were lower than in the previous year, and average winter temperatures were recorded as negative, which all resulted in a decrease in wheat grain yield this year.

Table 2. Chemical properties of the soil.

Type of soil	pH		Humus (%)	Nitrogen (%)	Available (mg/100g of soil)	
	H_2O	KCl			P_2O_5	K_2O
Alluvium	6,88	5,90	2,49	0,13	17,10	30,00

Soil acidity was determined by the Kappen method, humus was determined by the Kotzman method, total nitrogen was measured by the Kjeldahl method, and available phosphorus and potassium by the Engner-Riehm Al method. According to the pH values in KCl (5.90), alluvium belongs to the group of moderately acidic soils. Based on the humus content in the arable layer, it belongs to the group of poorly humus soils (according to Gračanin and Škorić). Alluvium has a medium concentration of nitrogen by the data related to the total nitrogen content. The concentration of phosphorus (17.1) classifies this soil in the group of moderately provided, while the content of potassium (30.00) classifies it in the group of highly provided. These data show that alluvium is favorable for wheat production.

RESEARCH RESULTS AND DISCUSSION

Wheat grain yield, as well as some of its qualitative characteristics, such moisture content, 1000 grain weight, and hectolitre weight, are conditioned by a number of environmental factors, the application of agrotechnical and variety selection. One of the most significant agro-technical measures that determine the wheat grain yield is the sowing period. A large number of both domestic and foreign researchers have been dealing with the optimum sowing time and the consequences of sowing wheat beyond the optimum sowing time, that is, delayed sowing. All of them agree that no agricultural measure can compensate for the loss in yield resulting from delayed sowing.

Table 3. Yield and some qualitative characteristics of wheat sown in optimal time and delayed sowing period

No.	A.Varieties	Moisture of grain (%)		1000 grains weight (g)		Hectoliter weight (kg hl^{-1})		Grain yield (kg ha^{-1})	
		A. Sowing term							
		Optimal	Delayed	Optimal	Delayed	Optimal	Delayed	Optimal	Delayed
1.	Opsesija	14.0	13.9	41.0	38.5	71.7	67.0	6.334	5.030
2.	Avenue	14.2	12.9	44.1	40.0	74.3	72.1	7.760	5.290
3.	Sosthene	13.1	13.2	40.0	39.7	74.7	71.2	5.968	4.580
4.	Farinelli	12.3	13.8	42.9	41.0	73.5	70.5	7.170	5.186
5.	Darija	14.0	13.0	41.0	41.2	62.9	69.0	6.650	5.370
Average		13.52	13.36	41.8	40.08	71.42	69.96	6.776	5.091
LSD		A	B	A	B	A	B	A	B
	5 %	1.31	1.33	4.08	4.10	7.30	7.02	0.61	0.50
	1 %	1.85	1.79	5.24	5.18	9.15	9.90	0.88	0.71

The grain moisture. This is a significant qualitative characteristics, which is very important from the aspect of safe storage of wheat in warehouses. In our researches, it ranged from 13.36 to 13.52% and there were no statistically significant differences between the sowing periods. The Farinelli variety had the lowest moisture content of 12.3% in the optimal sowing time, which was statistically significantly lower than the moisture of the Opsesija and Darija varieties.

Weight of 1000 grains. It is a very important qualitative characteristics of grain that has a strong impact on grain yield. The average weight of 1000 grains in the optimal sowing period was 41.8 g, while in the delayed time it was 40.08 g, which does not represent a statistically significant difference. The Avenue variety had the highest weight of 1000 grains (44.1 g) in the optimal sowing period, which was statistically significantly higher than the Sosthene variety. Our results are in agreement with

those of Gupta et al. (2017) who talk about the reduction of the mass of 1000 grains in later sowing periods, while the results of Yadava et al. (2018) talk about a significant decrease of the mass of 1000 grains of wheat if sowing is done after November.

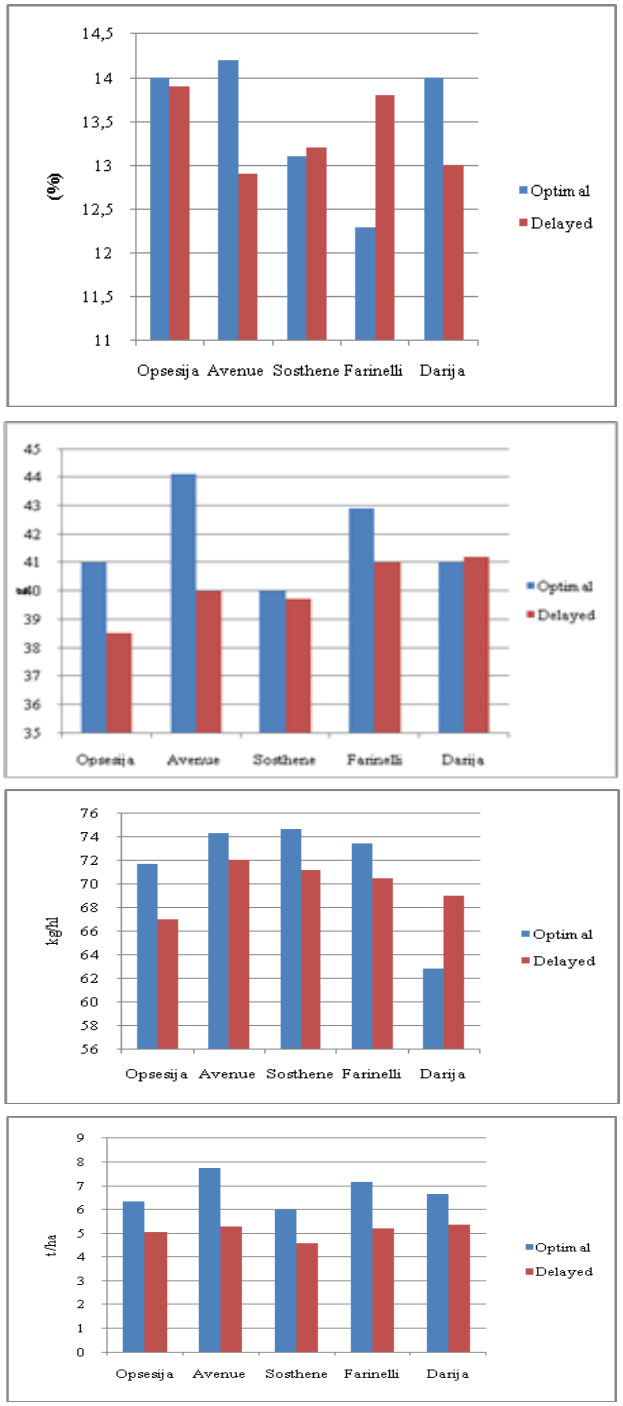
Hectolitre weight. This is an indicator of grain size and filling, and it is a very important parameter when buying wheat. On average, in the optimal sowing period, hectolitre weight was 71.42 kg, while in the delayed time, it was 69.96 kg, which does not represent a statistically significant difference. There were no statistically significant alterations in the hectolitre weight of the grains among the varieties, in the delayed sowing period, while in the optimal sowing time, the Darija variety had a significantly smaller hectolitre weight of the grains compared to other varieties.

Grain yield. This is the main goal of all producers, which is conditioned by a number of environmental factors and, above all, by the genetic predisposition of the crop to yield. The average yield of all varieties of wheat sown in the optimal time was 6.776 kg ha^{-1}, while of those sown in the delayed period was 5.091 kg ha^{-1}, representing a difference of 1.685 kg ha^{-1} which is statistically very significant. Also, all varieties had a statistically significantly higher yield in the optimal sowing period than those in the delayed sowing period. Furthermore, the varieties had a very significant impact on grain yield.

So, in the optimal time, the sowing varieties of Avenue and Farinelli had the highest yields (7,760 and 7,170 kg ha^{-1}), which were statistically significantly higher than the yields of the Opsesija and Sosthene varieties.

In the delayed sowing period, the yields were much more uniform, and the Darija and Avenue varieties had the highest yields (5,370 and 5,290 kg ha^{-1}), while the Sosthene variety had the lowest yield (4,580 kg ha^{-1}), which was statistically significantly smaller than with the Avenue and Darija varieties.

In the delayed sowing period, the Darija variety boasted significant yield, which was not the case in the optimal sowing period, so we can recommend it for sowing in this area in the delayed period. Thus, Suleiman et al. (2014) point out that those sowing varieties which are adapted to the delayed sowing can compensate for the reduced yield caused by delayed sowing. The average decrease in yield in the delayed period compared to the optimal time was 24.8%. The Avenue sort had the largest decrease of yield 31.8% while the Darija variety had the least decrease of 19.24%. In Graph 1, the difference is clearly noticed, both among individual varieties and among sowing dates. The claims of Aćina et al. (2016) show that sowing in December reduces the wheat yield by 20% compared to the sowing in the optimal time (first decade of October), and according to our results, we fully agree with them. Our results are in agreement with many authors' claims (Iqbal et al., 2001; Shah et al., 2006; Qasim et al., 2008; Gupta et al., Ali et al., 2010; 2017; Yadav et al., 2018), being that they highlight a significant wheat yield decrease that ranges from 27 up to 58% if sown outside the optimal time.



Graph 1. Influence of sowing time on wheat grain moisture (%),1000 grains weight (g), hectoliter weight (kg hl^{-1}) and grain yield (t ha^{-1}) of different wheat varieties

CONCLUSION

Based on the results of the research, the following can be concluded:

-The moisture content of the grain did not signifiancantly differ, either among the sowing dates or the wheat varieties.

-The average weight of 1000 grains of wheat was slightly higher in the optimal sowing period than in the delayed period. The Avenue variety had a maximum weight of 1000 grains.

-The average hectolitre weight of wheat grain was 1.46 kg ha^{-1} higher in the optimal sowing period than in the delayed one. The Darija variety had the lowest hectolitre weight of grain.

-The grain yield varied significantly, both depending on the sowing time and the variety. The average decrease in yield in the delayed period compared to the optimal time was 24.8%. Thus, in the optimal time, the sowing varieties of Avenue and Farinelli had the highest yields, while in the delayed time sowing varieties of Darija and Avenue had the highest yields.

-The Darija variety had the smallest decrease in yield in the delayed sowing period, so we can recommend it for sowing in this area in the delayed time.

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