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GRAIN YIELD AND YIELD COMPONENTS OF PROSPECTIVE HOMOZYGOUS WINTER WHEAT GENOTYPES

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Abstract: During the two-year research on the experimental field of the Grain Center in Kragujevac, the 1,000-grain weight, hectoliter mass and grain yield of ten prospective homozygous genotypes of wheat were analyzed. During the growing season, the average annual temperature and precipitation were favorable for growing wheat. In both growing seasons, precipitation was 120 mm more than the annual average, and 220 mm more in the second year. Genotype L-1/59 had the highest grain yield and the highest 1,000-grain weight, while the hectoliter mass was more or less equal to other genotypes. All genotypes had a satisfactory 1,000-grain weight ranging from 43 to 50 g. On average, all analyzed lines had a hectoliter mass greater than 80 for both years, which ranks them as high quality.

Keywords: grain yield, 1,000-grain weight, hectoliter mass, wheat

Introduction

The main task of breeding is the creation of hybrids and varieties of plants that, with optimal cultivation technology in specific environmental conditions, would have a high potential for yield. In the Republic of Serbia, in the last 20 years, grain yields have varied significantly, ranging from very low 2.2 t ha^{-1} in 2003. to 5.7 t ha^{-1} in 2021. The large fluctuations in yields indicate that we still depend to a large extent on climatic conditions, meaning that in climatically favorable years, we achieve relatively good yields, while in unfavorable years, yields are very poor (Dodig et al., 2015; Đurić et al., 2020). Factors that will be the main obstacles in the fight for higher production are unfortunately becoming more prevalent worldwide (Knežević et al., 2020). The reduction of freshwater quantity and its increasing contamination with various toxic and destructive substances will result in a further decrease in the already small

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areas under wheat irrigation. Soil degradation, both in terms of chemistry (increased acidity and salinity) and functionality, is present on large areas worldwide (Denčić et al., 2009). The emergence of new diseases and pests (such as the new race of stem rust Ug99) that can reduce yields by up to 50% is also a significant challenge (Braun et al., 2008). One of the extremely negative consequences of global warming will be heat waves, which in the grain filling phase can have catastrophic negative effects on both yield and quality. The higher cost of energy will undoubtedly lead to an increase in the prices of all inputs and, logically, producers will either significantly reduce the use of mineral fertilizers or refrain from their use altogether (Sayre and Hobbs, 2004). In the Republic of Serbia, compared to the ten-year average (2011–2020), cultivated areas of wheat increased by 9.4%, and average wheat yields range from 4.5 to 8 t ha^{-1}. Numerous traits play a key role in determining yield, and the contribution of each trait may vary among different genotypes and environmental conditions due to interactions within each genotype and between genotypes and environmental conditions (Đekić et al., 2015; Zuo et al., 2017; Grčak et al., 2019).

The work aimed to analyze the variability of the yield components, as well as the grain yield of prospective homozygous wheat lines.

Materials and methods

In the experimental field of the Center for Small Grains and Rural Development in Kragujevac, during a two-year study (2018/19 and 2019/20), grain yield, hectoliter mass and weight of 1,000 grains were determined for ten homozygous wheat lines: L-2/6, L-5/98, L-5/7, L-6/7, L-4/4, L-2/24, L-2/2, L-1/5 - 9, L-19/54 and L-3-2/3. The trial was conducted in a 5 m^2 plot with 10 rows, 12.5 cm between rows and 3 cm between plants in a row, according to a randomized block design with four replications. In both years, maize was used as a previous crop. The trial was sown in the second half of October (optimal time). Before sowing, 400 kg ha^{-1} of NPK (8:16:24) fertilizer was applied, and in the spring fertilization, an additional 300 kg ha^{-1} of ammonium nitrate (KAN) was added.

Meteorological conditions

The average annual air temperature in the first year of the research was 0.49°C higher than the thirty-year average, and in the second year it was higher by almost 1°C. Amount of precipitation for Kragujevac during the 2019/20 growing season it was 728.5 mm, which is 220 mm more than the multi-year average. The most precipitation in 2019 and 2020 was in June, with 143 mm in

2019 and 192.9 mm in 2020. Both the average annual temperature and the amount of precipitation in both growing seasons were above the long-term average (Table 1).

Table 1. Average monthly temperature and precipitation amount

	Average monthly temperature(°C)			*Precipitation amount* (mm)		
Month	2018/19	2019/20	1981- 2010	2018/19	2019/20	1981-2010
X	13.9	13.6	11.9	9.4	196	48.9
XI	7.6	11.7	6.4	41.8	68.1	49.5
XII	2.6	4.9	2.1	51.8	57.6	45.8
I	0.1	1.3	0.9	85.3	23.3	37.9
II	4.2	6.2	2.3	2.2	47.6	37.0
III	9.1	7.8	6.6	10	55.7	42.3
IV	13.2	11.8	11.7	35.2	17.8	53.9
V	14.5	15.7	16.7	125.3	7.9	58.7
VI	22.4	19.9	20.0	143	192.9	76.4
VII	22.3	22.0	21.9	83.2	61.6	57.7
Average/Sum	10.97	11.49	10.5	627.2	728.5	508.1

Results and discussion

Grain yield is a complex trait of exceptional economic importance, depending on several inherited characteristics and environmental conditions in which plants develop. Therefore, numerous researches in the field of genetics and plant breeding aim to contribute to a better understanding of both yield and its components, especially crops grown for grain production. Wheat yield and its components are quantitative traits that are significantly influenced by environmental factors and applied agronomic practices during the growth cycle of the wheat plant (Jaisi et al., 2021; Urošević et al., 2023).

The prospective wheat genotypes exhibited variations in grain yield, showing inconsistency across the years (Table 2). When observed year by year, there were no significant differences in grain yield, but the lines significantly differed from each other in terms of yield. Line L-1/59 had the highest average yield over the two years, followed by L-2/2, while the lowest yield was observed in line L-63/7. In the last 20 years in Serbia, wheat grain yields have varied significantly, ranging from 2.2 t ha^{-1} to 4.5 t ha^{-1} (Denčić et al., 2009). This yield variation indicates that grain yield is highly dependent on climatic conditions. Growing conditions (year) significantly influenced yield, and a significant interaction effect between genotype and year was observed (Zečević et al., 2010; Knežević et al., 2022; Matković Stojšin et al., 2022).

Hectoliter mass represents the weight of one hectoliter of wheat expressed in kilograms and is accepted as a measure of wheat quality due to its simplicity and quick determination. It can also serve as an indicative value for evaluating milling quality and ranges from 60 to 84 kg in wheat, with good wheat needing to have a hectoliter weight above 76 kg. All analyzed lines, on average for both years, had a hectoliter weight greater than 80, classifying them as lines of good quality (Table 2). Comparing the results of yield and hectoliter weight in this study, it is evident that the varieties that achieved high yields also had higher hectoliter mass.

Table 2. Grain yield, hectolitre mass and 1,000-grain weight of wheat genotypes

Genotype (A)	Grain yield (kg ha^{-1})			Hectolitre mass (kg hL^{-1})			1,000-grain weight (g)		
	Years (B)			Years (B)			Years (B)		
	18/19	19/20	*Average*	18/19	19/20	*Average*	18/19	19/20	*Average*
L-2/6	6361	5808	6084	81.1	79.5	80.3	44.0	42.36	43.18
L-5/98	6532	6200	6365	82.1	82.9	82.5	44.5	47.74	46.12
L-5/7	6000	6462	6231	82.1	83.3	82.7	44.35	44.52	44.44
L-6/7	5715	5978	5846	80.3	82.3	81.3	44.10	44.84	44.47
L-4/4	6090	5960	6025	80.3	83.3	81.8	45.70	46.86	46.28
L-2/24	6580	5833	6206	81.7	82.5	82.1	45.25	50.52	47.88
L-2/2	6710	6120	6415	85.5	82.3	83.9	47.30	44.56	45.93
L-1/59	6320	6650	6485	83.3	81.1	82.2	50.38	50.82	50.6
L-1/54	5870	6540	6205	84.9	83.3	84.1	47.48	47.26	47.37
L-32/3	5705	6420	6062	85.3	83.5	84.4	42.53	45.80	44.16
Average	6188.3	6197.1		82.66	82.4		45.56	46.51	
	A	B	AxB	A	B	AxB	A	B	AxB
LSD_{005}	196.7	107.4	274.3	0.25	0.17	0.46	0.27	0.19	0.50
LSD_{001}	340.9	182.5	457.3	0.42	0.29	0.79	0.46	0.32	0.86

The 1,000-grain weight depends on the variety, agroecological conditions, and production technology. Line L-1/59 had the highest 1,000-grain weight (over 50g) in both years, while the lowest was observed in line L-2/6. A weight of 1000 grains of 50g is an indicator of high grain yield (Kovačević and Rastija, 2014). Wheat variety is one of the most significant quality factors influenced by variations in the harvest year, region, and location (Kaya et al., 2014; Đekić et al., 2015). Growing conditions (year) significantly influenced yield, and a significant interaction effect between genotype and year was also observed.

Conclusion

Weather conditions in both observed growing seasons were relatively favourable for growing wheat, with average annual temperature and precipitation above multi-year averages. During the winter months in the observed period, there was significantly less precipitation, and the winter was mild, which positively affected wheat development and enabled high yields. In terms of yield, the best results were achieved by the L-1/59 line. This variety also had the highest 1,000-grains weight, while the hectoliter mass was comparable to other genotypes. All genotypes had a satisfactory 1,000-grains weight, ranging from 43 to 50 g. All potential future varieties had an average hectoliter weight of more than 80 kg for both years, which ranks them as good-quality lines.

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