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Specificities of growing seed wheat in agroecological conditions of Bosnia and Herzegovina

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Abstract

Winter wheat is the most important winter crop in Bosnia and Herzegovina as well as in the region. The yield of winter wheat varies depending on the variety and agroecological growing conditions. For sowing wheat, the sowing rate is 250-300 kg ha^{-1}. About 50,000 ha are sown annually in Bosnia and Herzegovina, which requires about 15,000 tons of seeds. From this quantity, about 10% of needs are met from own production, and the rest of the seeds are imported. This paper analyzes the production of seed wheat at one of the largest domestic producers of wheat seeds. The paper presents data on seed production in two years, at three locations with four genotypes. The obtained results show that superior yields can be achieved using appropriate agricultural techniques and an assortment with good genetic predispositions. Due to the specificity of climatic and edaphic factors, good results are also achieved when growing specific genotypes with increased protein and gluten content. Statistically highly significant ($p<0.01$) positive correlations were found between protein content and gluten content (0.98**). Highly significant correlations were found between hectolith mass and protein content (0.60**) and gluten (0.56**). The goal of the work is to increase the domestic production of seed wheat, as well as to carry out rezoning of the sowing of the appropriate assortment based on the analysis.

Key words: seed, variety, seed yield

INTRODUCTION

Wheat is the most important field crop and one of the most widespread cereals in the world, and according to the total sown areas it is in the first place (Kovačević and Rastija., 2014). It is grown on an area of about 213 million hectares, which makes it one of the most important crops (along with corn, soybeans and rice). The largest producers of wheat are India, Russia, USA, China (Faostat., 2018).

For a potentially high yield, it is necessary to grow varieties that are adaptable in the most important grain-bearing growing regions, and have high resistance to low temperatures, drought, important diseases and pests, and are tolerant to grain shedding at harvest time (Đurić, 2012).

Feeding a growing global population in a changing climate represents a significant challenge for society. Climate change affects cereal production mainly through heat and water stress, the problem of increased carbon dioxide concentration, the problem of freezing and the dynamics of the occurrence of diseases and pests. (Roncevic, 2020). The basic condition for achieving high and stable yields is the selection and use of certified seeds, using appropriate cultivation techniques (Boshev et al., 2016).

In Europe, wheat is grown on about 58 million hectares with an average yield of 3.72 t ha^{-1}, which gives a total production of over 215 million tons. The largest producers of wheat in Europe are: Russia, France, Germany, Ukraine and United Kingdom.

Of the total areas where grain is grown in Bosnia and Herzegovina, 69.3% is located in the Republic of Srpska. Wheat is grown on 18.4% of the sown areas and in the Republic of Srpska there is a constant decrease in areas. According to statistical data, in the past ten years, the area under wheat has been decreasing, but there has been an increase in the yield per unit area with improved agricultural techniques and the introduction of a new assortment. In Bosnia and Herzegovina, wheat seed production covers about 10% of the total needs for sowing.

In order for new varieties to approach and become interesting to agricultural producers, it is necessary to show their characteristics and possibilities in areas with different climatic and soil characteristics. Currently, in Bosnia and Herzegovina, about 30% of the genetic potential of varieties is used, and about 50% of the production potential, which is very little (Mandic et al., 2020).

The goal of the paper is to increase the production of seed wheat with good qualitative and quantitative characteristics and increased resistance to diseases and pests. The introduction of new varieties adaptable to our agroecological conditions and the production of seeds of those varieties in the future will have a positive effect on the production of seed and commercial wheat in Bosnia and Herzegovina.

MATERIAL AND METHODS

In the sowing structure of wheat, Bosnia and Herzegovina uses very little seed from its own production (<10%). Most of the seeds are imported.

In this paper, the data of a domestic seed producer that multiplies seeds of foreign varieties in the territory of Bosnia and Herzegovina are processed. Four new wheat genotypes (foreign varieties) were used. Selected genotypes were sown at locations in Derventa, Grahovo and Odzak. In the first year (2018/2019), three varieties were sown at the Odzak location, and in the following year (2019/20), four varieties were sown at three locations (Derventa, Odzak, Grahovo). In both years, the size of the sowing area for all varieties was between 40 and 130 ha, and the results were based on average values.

All sown varieties are of high genetic potential, early varieties, tolerant to lodging as well as the most important diseases, especially *Fusarium.* The sowing rates of these varieties are different and range from 350-400 germinating grains per m^2 to 650 to 700 germinating grains per m^2. The optimal sowing dates for these varieties are from October 10 to 31. Seed crops were treated with herbicides for weed control, and treatments for disease and pest control were also performed. Crop feeding was done on three occasions, the first and second feeding with KAN (150 kg ha^{-1}), and the third with AmoSulfan (100 kg ha^{-1}). The harvest was done at the optimal time in early July when the humidity was less than 14%.

After harvesting, the natural seed yield was determined for each seed lot. Among the qualitative characteristics of all varieties, the content of protein, gluten and hectoliter weight were determined.

The locality, Derventa, is characterized by pseudogley soil, which contains very little humus in its composition. The content of readily available phosphorus is low, while the content of potassium is at a satisfactory level for the needs of wheat. Soil is a slightly acidic chemical reaction.

The content of readily available phosphorus and potassium is at a satisfactory level for the needs of wheat. At the location of Odzak, the soil is characterized by a slightly acidic reaction. The locality, Grahovo is characterized by carbonate soil. The content of humus is moderate, while the content of readily available phosphorus is low and the content of potassium is favorable. The soil is characterized by a slightly acidic reaction.

Table 1. Results of the chemical analysis of the arable soil layer at the Odzak location

Label plots	Reaction (pH) in		Hummus %	P_2O_5 mg/100 g	K_2O mg/100 g
	H_2O	KCl			
Odzak	5.8	4,4	3.0	14.09	20.53
Derventa	5.8	4.7	1,2	5.67	24.77
Grahovo	5.9	4.7	2.5	3.83	15.08

In the analysis of the results of this work, the meteorological parameters at all three locations were taken into consideration. In 2019 and 2020, the total amount of precipitation was slightly lower than the average, the slightly higher amount of precipitation in May and June had a positive impact on the yield. Temperatures were within the range of multi-year averages.

The results of biometric measurements were processed with PC applications for *Statistical Package for Social Sciences* and *Excel*. Correlative relationship between the studied properties were calculated as *Pearson's* correlation coefficients, and the significance of the links was determined.

RESULTS AND DISCUSSIONS

In order to ensure the right recommendation of genotypes for different regions, cultivation and agroecological conditions, a common practice among seed growers is to test the cultivation of genotypes in different seasons and localities. In this approach, the "crossover" type of interaction between genotype and environment is a frequent occurrence (Yang, 2007), changing the performance of cultivars in different localities.

Low yield stability in winter wheat is the main factor that determines the actual yield compared to the potential (Tollenaar and Lee, 2002; Nielsen and Vigal, 2018). In wheat breeding and seed breeding, the interaction of genotype and environment complicates the selection of superior genotypes and reduces genetic progress (Peric et al., 2020).

Wheat variety is one of the most important quality factors, with expression all qualitative indicators depend from the conditions which vary in framework locality, region and growing seasons (Mladenov et al., 2001). The quality of the most represented varieties of wheat in wide production constantly improves, or is maintained at the achieved level (Đurić et al., 2012).

Table 2. Yield data and quality of seed wheat for the period 2018-2019 years

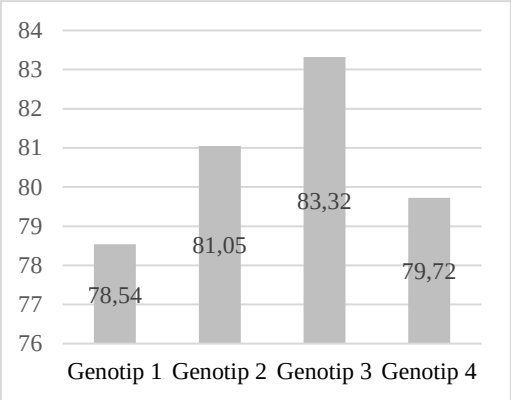
Sort	Location	Average yield (t ha $^{-1}$)	Area (ha)	Hectoliter mass (kg hl $^{-1}$)	Protein (%)	Gluten (%)
Genotype 1	Odzak	6.48	41.6	67.9	11.7	21.3
Genotype 2	Odzak	2.52	76.5	73.9	12.2	25.4
Genotype 3	Odzak	2.86	94.1	75.5	14.2	32.1

Production is an interaction between agroecological conditions and genotype. It is very important to base the seed production of a certain genotype in the area where it achieves the highest yields (Table 2). In the same agroecological conditions, in the same year, Genotype 1 achieved twice the seed yield compared to Genotype 2 and Genotype 3. The continuous increase in yield continues remains the main one priority occasion development new one's varieties across Saint (Dencic et al., 2008; Mirosavljevic et al., 2016). How would be se insured rights recommendation of genotypes for different regions, eats him and agroecological conditions, usual practice among breeders represents testing genotypes in different seasons and localities.

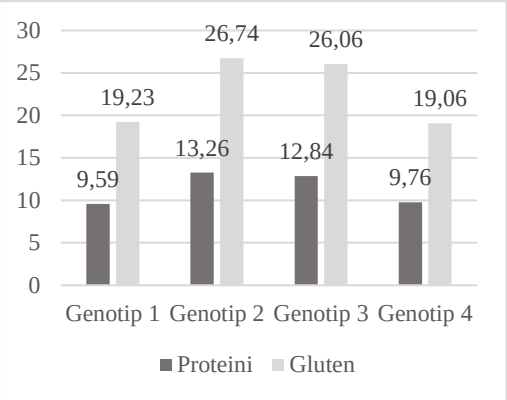
Table 3. Yield data and quality of seed wheat for the period 2019-2020 years

Sort	Location	Average yield (t ha $^{-1}$)	Area (ha)	Hectoliter mass (kg hl $^{-1}$)	Protein (%)	Gluten (%)
Genotype 1	Derventa	3.81	124.0	78.54	9.59	19,23
Genotype 2	Grahovo	3.49	55.0	81.05	13,26	26.74
Genotype 3	Grahovo	4.01	59.6	83.32	12.84	26.06
Genotype 4	Odzak	7.70	85.0	79.72	9.76	19.60

In 2019-2020. In 2008, four genotypes of seed wheat were sown in three localities. Seed yield in all localities was quite high (Table 3). The highest seed yield was achieved with Genotype 4 at the Odzak site (7.7 t ha $^{-1}$).



Graph 1. Hectoliter mass (kg hl $^{-1}$)



Graph 2. Protein and gluten content (%)

Based on the analysis of the qualitative characteristics of seed wheat, it can be concluded that Genotype 3 (83.32 kg hl^{-1}), which was sown at the Grahovo location at 910 m above sea level, had the largest hectoliter weight (Graph 1). The highest content of protein and gluten was achieved in the genotypes grown at the Grahovo location. Quality wheat can improve selection optimal times sowing for every region cultivation wheat. Numerous the authors report a negative correlation between yield and protein content in wheat grain (Kibite and Evans, 1984; Bogard et al., 2010). The variation of gluten content and quality in wheat genotypes is determined by genetic factors, environmental conditions and the interaction of genotype and the external environment (Naeem et al., 2012).

Table 4. Correlation coefficients between the investigated properties

	Average yield	Hectoliter mass	Protein
Hectoliter mass	-0.003		
Protein	0.320*	0.600**	
Gluten	0.302*	0.564**	0.980**

p<0.05*; p<0.01**; N=56.

Pearson's correlation coefficients were determined between the examined qualitative traits and seed yield. A significant correlation was established between the yield of the tested genotypes and the content of protein and gluten. A very high correlation between the quality parameters was found. The highest correlation was found between protein content and gluten content (0.98**). From these parameters, it can be concluded that in the cultivation of seed crops, an important factor in addition to the yield is the quality of the seeds.

CONCLUSION

Based on the above, we can state that quality seed wheat can be produced in our agroecological conditions high yield.

The best conditions for production are in the area of Odzak, where in 2019/20. In 2019, the highest yield was achieved with Genotype 4 (7.7 t ha $^{-1}$), while the highest yield in 2019/20 in the same area achieved with Genotype 1 (6.6 t ha $^{-1}$).

In the area of Grahovo, which is located at 910 m. n. c. good yields of seed wheat with high protein and gluten content were achieved.

The determined correlation coefficients show that by increasing the quality of one parameter of the seed, other parameters also increase. A highly significant correlation was found between protein and gluten content (0.98**).

In the production of seed wheat, it is very important to carry out regionalization of production, for which Bosnia and Herzegovina has favorable agroecological conditions for seed production.

The production of seeds of different varieties specific to individual areas should promote the seed production of wheat, and at the same time the sowing of larger areas of higher quality and economically justified commercial wheat.

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